SHORT CUTS IN AUTO REPAIRING

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FOREWORD

IT is to meet a popular demand that this book is presented to the automobile public. Solutions to many perplexing problems will be found, so clearly explained and illustrated that the reader will wonder "why I never thought of that."

If there is any truth in the old proverb that "Time is Money," we may say that every hour we save by accomplishing some difficult task *the easy way,* is also money saved.

The purpose of this book is to show *the easiest way,* and if it helps each one of its many thousands of readers over a few complicated repair jobs, its mission will have been fulfilled.

AUTOMOBILE DIGEST
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SHORT CUTS
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CHAPTER I

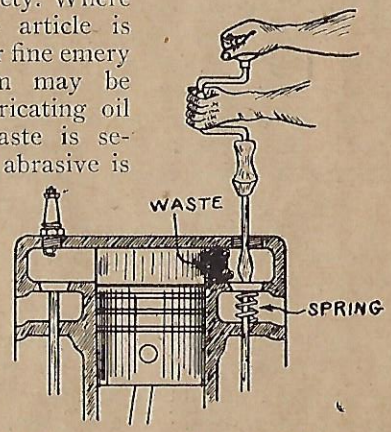
Grinding Valves

THERE is no set rule for the frequency with which valves must be ground. A careful driver may get several times the mileage that another may get with the same car. The many factors which enter into the life of a valve seat, and in the frequency of grinding, must all be taken into consideration. Imperfect cooling of the seats; springs too strong, causing hammering and premature wearing out of the seats; over-lubrication, causing pitting and sooting—are all factors that reduce the life of perfect valve action.

Leaky valves manifest themselves through loss of compression, while the spark plugs, due to the poor combustion, may have an oily or sooty appearance. The exhaust valves, due to the intense heat of the escaping gases, are frequently the cause of trouble. The seats soon become pitted; carbon dust is confined in every little crevice, and soon the valves are covered with a carbon deposit which greatly affects the running of the motor. When valves have reached this condition, there is but one remedy—and that is regrinding.

Valve grinding is a simple process, though it must be carried on carefully to secure the best

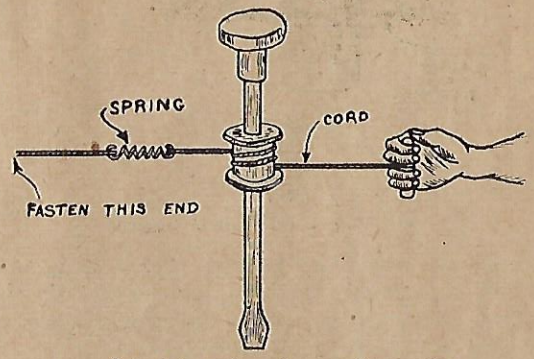
results. The valve mechanism is disassembled so that the valve may be lifted out. A generous supply of waste or cloth is placed between the valve chamber and the cylinder so that none of the grinding compound can work its way into the cylinder. There are several good grinding compounds on the market which may be used with perfect safety. Where the home-made article is preferred, either fine emery or carborundum may be mixed with lubricating oil until a light paste is secured. A little abrasive is placed on the valve seat, and after the valve is replaced, it is given a partial revolution, back and forth, on its seat. A common method of imparting this revolution is by means of a carpenter's brace, carrying a bit which fits the valve head. The valve head should never be given a full revolution—from one-fourth to one-half turn is sufficient, and it should be lifted occasionally and given a new position on its seat. A spring placed under the valve head will cause it to raise whenever the pressure is released. The grinding is continued until all pits and



Grinding valves with a carpenter's brace.

ridges are removed. The valve head and seat valve are then carefully cleaned with gasoline; Prussian blue is applied to the valve head, which is replaced on its seat and given a one-fourth revolution. If the valve seat shows blue all around, the grinding is completed; otherwise it must be continued.

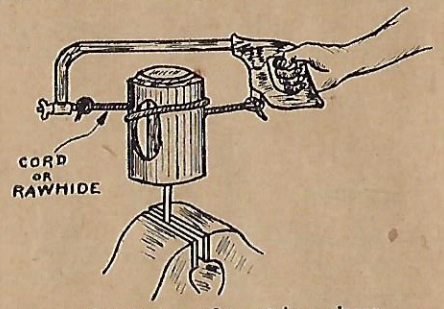
An easily constructed tool for grinding valves is shown in the illustration. It consists of a



A tool to make valve grinding easier.

round rod, one end of which is made to fit the valve head. The other end carries a knob in which it turns freely. Below the knob is a spool which is pinned to the rod. A cord passes twice around the spool and carries a handle at one end. The other end of the cord carries a spring which is fastened by another cord to any convenient place. Pulling on the cord causes the rod to turn, while the spring supplies the reserve motion.

Valves set in a sleeve may be quickly and easily ground by using the method shown in the illustration. The valve stem is held in a vise, between two blocks of wood. A piece of cord or rawhide, held in a hacksaw frame, is wrapped once or twice around the sleeve. By drawing the hacksaw frame back and forth, in the same



Grinding a valve set in a sleeve.

manner as used for cutting metal, a turning motion is imparted to the valve sleeve. By this method and with the use of the proper abrasive, the valves may be easily ground.

Electrical Connections

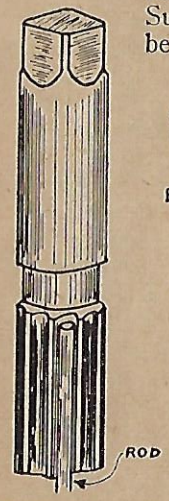
When looking over the electrical system, care should be taken that all connections are clean and tight. Loose connections leading to the lights are the cause of flickering and, at times, no light whatever; while dirty connections are the cause of dimmed brilliancy, due to the resistance interposed to the passage of the electrical current. All fuses must be considered as connections and should be kept tight and clean.

The battery connections are perhaps the most important where a starter and generator is a part of the electrical system. Loose and dirty battery connections will readily manifest themselves when an attempt is made to use the starter. Though a source of trouble, they would cause no harm if only the starter were to be considered. But it is because of the damage which may be done to the generator and other electrical equipment that care should be taken that the battery connections are in perfect condition. The methods of controlling current output differ according to the make of the electrical system. Where the battery is necessary to control the voltage of a generator, a loose or corroded battery connection eliminates the battery as the controlling factor. The generator, therefore, produces an excessively high voltage (at times as high as 50 volts) which, if delivered to the lights, would force such an excessively high amount of current through them so as to burn them out. Other electrical equipment would also be strained and perhaps permanently injured. With the voltage regulator type of control, the voltage is held practically constant whether the battery is connected or not and the danger of injury to the equipment is eliminated. No matter what type of generator is used, it is always best to play safe and keep the battery and its connections in the pink of condition.

About Reamers

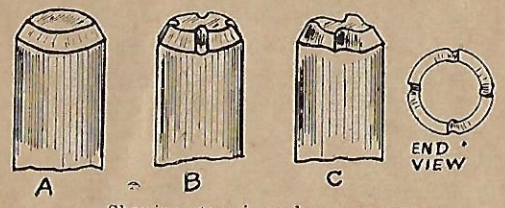
Reamers are used to enlarge a hole to a determined size and to impart a smoot finish to the

sides of the hole. The common type of reamer is constructed from a solid piece of steel and is non-adjustable. Hence, after a certain period of usefulness, the reamer becomes reduced in diameter as the cutting edges have lost their sharpness. Grinding remedies the dull condition, but it further reduces the diameter. Such a reamer, however, need not be discarded if the "kink" shown in the following illustration is employed. A piece of heavy wire or drill rod is placed in one of the flutes of the reamer. This wire should be of such thickness so as to extend slightly beyond the cutting edges. As most reamers are made with flutes of varying depths, the wire may be moved from one to the other to increase the depth of the cut.

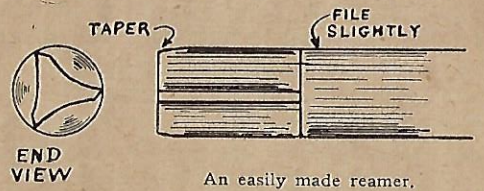


Showing how to make a reamer cut oversize.

It sometimes happens that a reamer cannot be found for the work on hand. When such is the case, a modification of a rose reamer may easily and quickly be made. The illustration shows the steps in making such a reamer. At *A*, a bar of steel is given a short taper on the end. At *B*, the tapered portion is filed to produce four or more semi-circular grooves. At *C*, the grooves are backed off to one side so as to produce the cutting edges. After hardening and tempering, the reamer is ready for use. A reamer of this type can only be used in a lathe or drill press, as the taper is too short to give the proper support for hand reaming, and it should only be used to remove a comparatively large amount of metal, never less than $^1/_{32}$ of an inch. A rose reamer will usually cut slightly oversize.



Showing steps in make a rose reamer.



An easily made reamer.

For hand reaming, a reamer, as shown in the sketch, may easily be made. The shank of the reamer should be filed slightly smaller to prevent binding. The work can be quickly done on an emery wheel.

One thing to remember when using a reamer

is never to turn backwards, as nothing is more injurious to the cutting edges.

Focusing and Adjusting Headlights

When replacing bulbs in the head lamps, it is always necessary to adjust the focus so that no dark spots or rings appear in the illuminated area ahead. If the bulb is placed too far from the reflector, a dark spot will appear; if too close, the light will be diffused over too great an area and will not penetrate the darkness for any great distance. Perhaps the best method would be to direct the light upon some smooth vertical surface about ten feet away. Then, by regulating the adjusting attachment, the bulb and socket is moved in or out until no dark spots appear in the illuminated area.

Correct alignment of the headlights is also a necessary factor in securing correct illumination. Headlights tilted in any direction, except in one which will deflect the rays of light directly ahead, are practically worthless. Again, the rays of light should be so deflected that they will not rise more than perhaps four feet above the ground and should illuminate the roadway for perhaps 100 feet. Where the lamp reflectors are themselves adjustable, proper alignment may be easily obtained. Where there are no adjustable reflectors, however, the arms of the lamp brackets must be bent with a heavy wrench until the light from each lamp strikes the road at the point desired.

Tightening Nuts

At times, the threads of a bolt and nut become so worn that they are practically useless. Where another set is readily procurable, the trouble is easily remedied. But where the nut is of the crown shape or any of the other attractive shapes which are used for the exterior hardware of the car, and especially where the bolt threads are not standard, remedial measures become quite a problem. A good remedy is to increase the diameter of the bolt thread, thereby taking up the wear. A saw slot is cut across the diameter of the thread, as shown in the illustration, and the bolt is then spread apart with a chisel.

Showing how to tighten a bolt in its nut.

Overheating of the Engine

It is generally the cooling system which is blamed when the motor overheats. Yet there are many causes, seldom thought of, which will produce the same result. Perhaps a too rich mixture is supplied by the carburetor. A mixture containing too much gasoline vapor is slow burning and has more heating value, without producing a proportional increase in power, than a mixture which is of the proper proportions or has an excess of air. As the combustion is therefore not perfect, there is a loss of power and the surplus heat liberated

every explosion must be absorbed by the cooling system.

Again, the oiling system may be clogged or for some other reason, may not be properly lubricating the mechanism of the power plant. Defective lubrication is the cause of much power being absorbed in friction, and where there is friction heat will be present.

Driving with a retarded spark is also a cause of heating. When the spark occurs late in the cycle, the piston has passed its highest point and has completed a portion of the next downward movement. This has given the compressed gas a chance to expand before it ignites, and the resultant power is less than it would be with a higher degree of compression. To secure power, it is necessary to supply more gas to the cylinders.

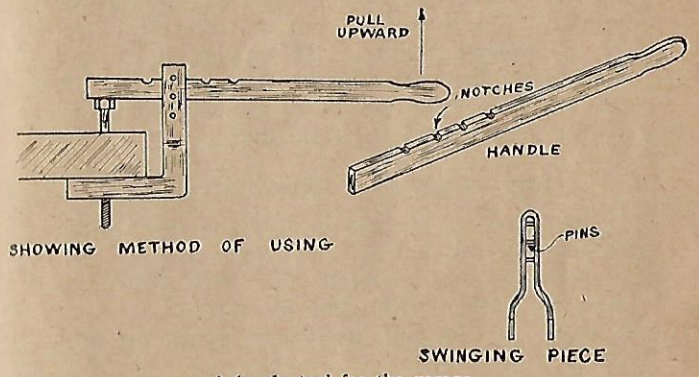
Another cause of heating may be attributed to driving in the lower gear too long. When the lower gear ratios are used, considerable power is absorbed by the friction of the gears in the change speed gearset. In the high speed or direct drive, practically the only power lost is at the driving gears in the rear axle.

A Bolt Driver—A Handy Tool for the Garage

The auto repairman frequently encounters tight bolts or pins which defy the usual methods of removal. Blows from a hammer not only disfigure such bolts or pins, but sometimes cause them to buckle in their holes. When this happens the only method of removal is by drilling, which consumes much time and requires a lot of "elbow grease."

A bolt which will resist the blows of a hammer will usually move when a steady pressure is applied. The bolt driver shown in the illustration is based on this principle and will be found invaluable in the garage or repair shop.

The notches in the handle provide adjustment, so that bolts in various positions may be easily reached. By using three pins in the swinging



A handy tool for the garage.

portion, adjustment for different thicknesses of work is provided for. This tool is also useful for driving bushings, arbors, etc.

Clogged Mufflers

The purpose of the muffler is to reduce the pressure of the gases by expansion to a point where they will emerge into the atmosphere

without noise. This is generally done by providing a number of concentric chambers, each larger than the other. The exhaust gases, in passing through, expand from one to the other until, at the outlet or largest chamber, they pass practically noiselessly into the atmosphere.

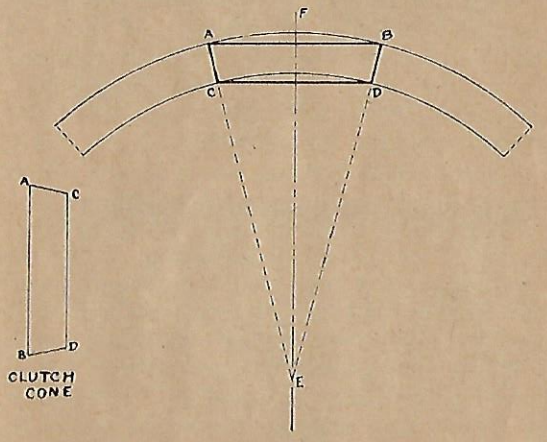
The muffler, after long service, becomes choked with carbon deposits and a considerable back pressure is created. This back pressure is the cause of loss of speed and power in the engine with subsequent overheating. When the engine mysteriously loses power, it is well to look at the muffler. The use of the cutout will readily detect a clogged muffler. By tapping lightly all over the muffler with a mallet or a piece of wood, the carbon deposits will be so loosened that they will be blown out by the exhaust.

How to Lay Out Clutch Leathers

The secret of success in applying new clutch leathers lies in getting the proper shape. Attempts to reface a clutch cone with a straight piece of leather will result in failure—it can't be done. To lay out the proper shape, the process is as follows:

On a straight piece of paper, draw the line *AB* equal to the largest diameter of the cone. At a distance equal to the thickness of the cone draw *CD* equal to the smaller diameter. These lines should be drawn so that the line *FE* passes through the exact center. Connect the two lines forming the figure *ABCD*, which is the shape which would be found were the clutch cone cut through the center. Now continue *BD* and *AC*

until they strike the center line at *E*. Using *E* as a center, draw a portion of a circle so that it passes through *A* and *B*; still using *E* as a center, draw another portion of a circle passing through *C* and *D*. This is the shape to which



Method of laying out clutch leathers.

the leather must be cut in order to lay flat on the cone. The length should be slightly more than three times the distance *AB*. The paper is cut out on the lines and used as a sample for cutting the leathers.

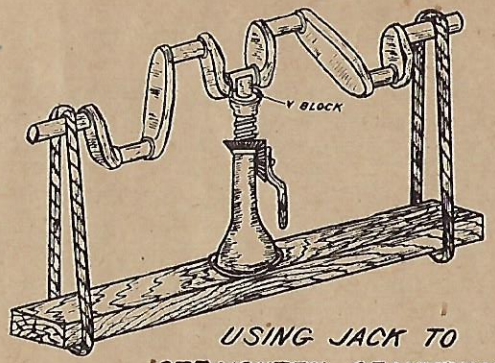
CHAPTER II

Straightening Crankshaft

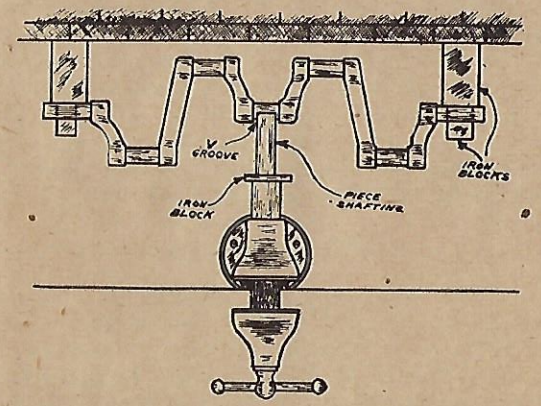
ON many of the lighter cars, an occasional source of trouble is the bending or springing of the crankshaft or camshaft. If the bend is not too great, the shaft may be easily returned to its original shape. For this purpose, a shaft straightening press is used, which consists of two V-shaped supports for the ends of the shaft, and a screw which tightens down on the center of the shaft. A test indicator is in contact with the center crankpin and indicates when the shaft runs true. For the small-sized shop, or for the car owner, such a tool would prove an undesirable expense and some improvised method is necessary. The accompanying illustration shows two such methods which will give satisfaction.

The first illustration is practically self-explanatory. Chains, in place of the ropes, would be better, though if such were used, it would be advisable to provide temporary bushings for the ends of the shaft to prevent injury. A screw jack is best for this purpose, as finer adjustments can be made.

The second illustration shows how the vise may be called into service. With this method, it is necessary that the work-bench be placed against a solid wall and firmly secured. The shaft is carried on two blocks of iron and is held away from the wall by two more blocks. The tail of the vise is closed by an iron block,



USING JACK TO STRAIGHTEN CRANKSHAFT.



STRAIGHTENING WITH VISE.

TOOL FOR TESTING.

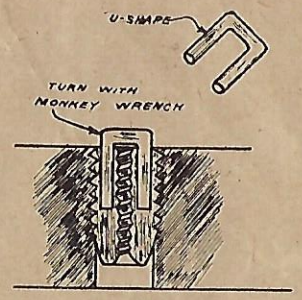
limit with a minimum danger of destroying the threads. The graphite will also assist materially in preventing the leakage of compressed gas around the plugs.

As a squeak preventer it is a reliable agent. Springs, or any other parts which have a tendency to rub against another, may be treated with the graphite grease with perfect satisfaction.

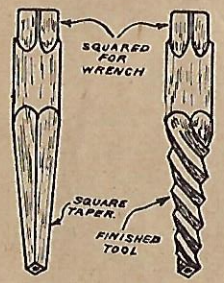
Removing Broken Taps or Screw Bolts

To remove a broken tap is sometimes quite a problem, especially if it breaks off below the end of the hole, which is frequently the case. The method generally employed is to try to back the tap out with a hammer and chisel. Occasionally, this procedure results in success, but in the majority of cases it only results in jamming the tap tighter in the hole. One thing to be remembered when a tap breaks is that hammering on the tap may simply aggravate the condition. A tap is highly tempered and hammering may splinter it, making removal impossible.

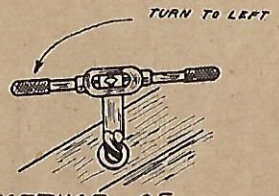
The first thing to do is to see if the tap is loose or tight in the hole. If loose, so much the better; if tight, it must be loosened. This may be done by filling the hole with nitric acid, allowing it to stand for some time. Care should be taken that the acid does not come in contact with the clothes or skin. After the acid has been removed, the hole is thoroughly washed with water. It will be found that the acid has eaten the tap somewhat, making it loose in the hole. A heavy piece of wire is then bent U-shaped, as shown,



REMOVING BROKEN TAP.



TOOL FOR REMOVING BROKEN SCREWS.



METHOD OF USING TOOL.

and inserted in the flutes of the tap. Turning with a monkey wrench completes the job.

Where the tap is rather small and the surrounding parts will stand heating, the tap may be heated to redness, which withdraws the temper. When slightly cooled, the tap may be drilled out, using a drill smaller than the tap itself, so as not to enlarge the hole or destroy the threads. If the tap drill is used, and the tap is drilled through the exact center, the threads will readily drop out. If they do not, a piece of metal may be inserted in the drill hole and the tap backed out.

A broken bolt presents practically the same problem, except that there are

no flutes into which a wire may be inserted. The bolt, however, has the advantage of being soft and therefore easily drilled. A remover may be made by filing a piece of steel to a square taper, as shown. This piece is then heated to redness, is then held in a vise by the end and given several turns to the right, which roughly forms a left-hand spiral. The piece is then tempered and inserted in a hole which has been drilled in the broken bolt. By turning to the left, the tool works its way down into the hole in the bolt until it becomes tight, when the motion is taken up by the bolt. In this manner, the most stubborn bolt may be withdrawn.

Scored Commutators

When the commutator and vibrator coils are used as a source of ignition, erratic firing often results from wear in the commutator. The constant rotation and pressure of the roller contact arm against the inside wall of the commutator will naturally cause wear and tear in time. The steel contact segments gradually become ridged or worn below the surface of the fiber, while the fiber itself becomes considerably roughened. At low speeds, such a condition does not occasion any great amount of trouble, as the roller contact has time to follow any irregularities and may readily make contact. At high speeds, however, the contact practically leaps over any low or roughened segments and erratic firing is the result. The only remedy is to chuck the commutator in a lathe or grinding machine and true up the inside surface. Attempts to take a light cut

out of the timer interior will meet with failure, as the contact segments are made of tool steel and hardened. The commutator is placed in a lathe or grinding machine and the interior is ground perfectly round and smooth with a small emery wheel. Where the fiber is worn below the contact segments, the segments may be ground down with a fast-running, free-cutting emery wheel. Care must be taken that no fiber insulators are broken or cracked so that there may be no opportunity for a leakage of current. The Ford commutator should be especially well treated, as the higher voltage of the ignition current makes any defective fibers a more fertile source of trouble.

Tarnished Brass

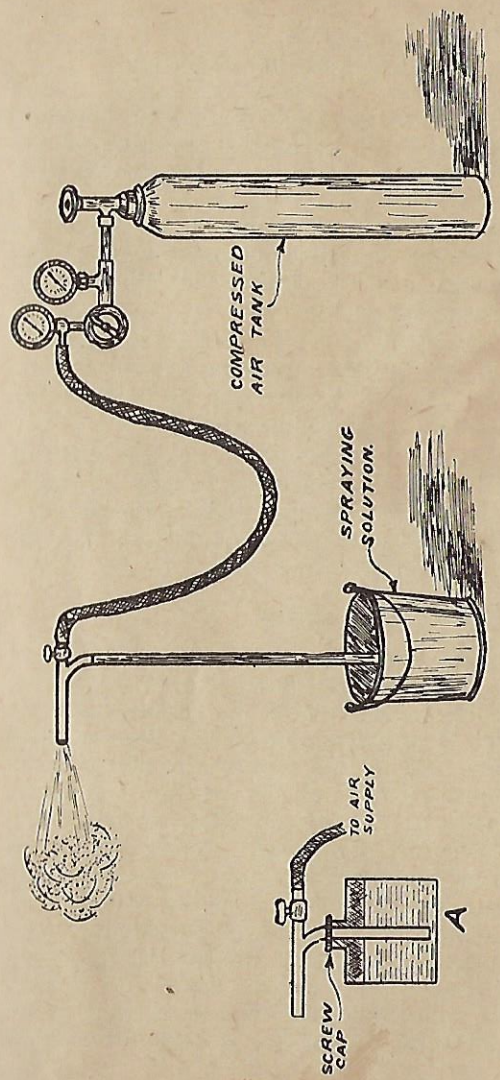
When the brass-plated parts have become tarnished, a solution composed of an ounce of alum dissolved in a pint of water will be found of advantage. This solution only requires to be rubbed on the surface and then wiped off. It will readily remove the tarnish and will not injure either the skin or the metal.

Spraying Device

The garage, or repair shop, having a source of compression air, may make use of the siphon principle for a variety of purposes. The most common examples of this principle are the ordinary atomizer and the garden spraying apparatus. The rather weak air supply of these, however, makes them impractical for any other use than that for which they are intended; but modifica-

tions may readily be made and they may be adapted for more practical purposes. Perhaps the most useful purposes to which the siphon principle may be aplied are the painting of automobile radiators and the washing down of the motor and parts. The painting of radiators with a brush is a long, tedious and unpleasant task. The application of an even coat of paint is in itself an art. If the paint is applied too thick, the function of the radiator is impaired to a certain extent; if applied too thin, the finish will not last. The use of some sort of a spraying device will make it possible to apply a practically even coat. The advantage of using a kerosene spray for cleaning the motor and other difficult parts can also be readily seen.

A simple and effective spraying apparatus may be easily made. The nozzle is simply a piece of metal tubing (about ¼" or 5/16") to which another is soldered at practically a right angle. There is an unobstructed air passage through both pieces of tubing. A stop cock is inserted in the tube which carries the supply of air, while the other is connected to the paint or cleaning supply. The rush of air through the air tube draws the solution up through the other tube and expels it in the form of a spray. In Fig. *A*, the nozzle and solution supply are practically one. The supply tube of the nozzle passes through, and is soldered to a cap, which screws to the top of the can. Filling of the can is accomplished by screwing out the cap and nozzle. This method gives a wide latitude in moving from part to part, as the only limitation is the length of the air



A SIMPLE SPRAYING DEVICE.

CHAPTER III

Easiest Way to Remove Carbon

THE causes of carbon deposits are the use of an improper lubricant or the excessive use of a good lubricant. The effects of carbon deposits are loss of power, overheating and knocking. Carbon deposits may be prevented by injecting a tablespoonful of kerosene in each cylinder once a week. This should be done while the engine is still warm and should be permitted to remain over night. On starting the motor in the morning, the carbon will be blown out through the exhaust.

When the motor has been neglected and the carbon deposits have become thickly encrusted, the above method will have little, if any, effect, and other means of removal must be employed.

Perhaps the most up-to-date method is the burning out of the carbon by the means of pure oxygen. This process is simple, requires but little work, and can be cheaply and quickly done. The spark plugs and valve caps are removed; a small quantity of kerosene is injected into the cylinder head and ignited. The introduction of oxygen, under a pressure of about five pounds per square inch, supports the combustion of the kerosene; the carbon deposits ignite and continue burning until they have been consumed. The spark plugs and valve caps are then cleaned by scraping and replaced in the engine. Though perhaps the simplest method, there are times

when oxygen cannot be used or is not obtainable and the old time methods must be employed.

Where the cylinder heads can be removed, the operation is quite simple. But when the cylinder heads are cast integral, it is sometimes quite a problem to scrape carbon without dismantling the engine. However, there are means which will give satisfaction, provided the deposits are not too severe. The first of these methods is by the use of a steel cable, as shown in the illustration. A brass tube is given a short 90-degree bend at one end. The steel cable should be unwound at one end to form a brush and is passed through the tube. The cable should be small enough to pass through the tube without binding. The curved end of the tube is inserted into the combustion chamber, and the cable is worked up and down in the tube, as if pumping. This pumping operation causes the steel wires to scratch off any carbon with which they come into contact. There need be no fear of spreading the wire strands too far apart and thus making the brush too large for insertion into the combustion chamber, as by slightly drawing the brush end up into the tube, its size may easily be made to conform with any opening into the chamber. If this method is unsuccessful in removing the carbon, a more drastic one must be employed, such as a chain mop as shown in the illustration. This consists of a small motor carrying a flexible shaft, to the free end of which is fastened several short lengths of chain. When the flexible shaft revolves and attains any great speed, the chain will spread out and break

off the carbon. It is advisable to again use the steel cable brush after this operation.

When all other methods fail, the carbon must be removed by scraping. On some types of motors, this may be quickly and effectively done with the special type of scraper shown in the illustration. A piece of round stock, bent to form a handle at one end, passes through a plug which is screwed into the cylinder head instead of the spark plug. A scraper blade is carried on the other end and is made to revolve inside the combustion chamber when the handle is turned. The scraper blade should be slotted where the screws pass through, so that fine adjustments may be made. This scraper will remove the carbon from the top and sides of the cylinder and from the top of the piston.

The tools thus far described may all be used without disturbing the engine in any way, other than the removal of a spark plug or valve cap. The loosened carbon must be removed from the cylinder, which may be easily done by the use of compressed air and the aid of the simple attachment shown. This consists merely of an ordinary T-pipe connection, which carries a smaller tube passing through its centre. A compressed air hose is connected to the inner tube. The introduction of the air causes the loosened carbon to seek some means of escape, and as there is only one path, the T connection, the carbon is forced out of the combustion chamber.

Hand-scraping is perhaps the most effective method of removing carbon, but it consumes more time, due to the inaccessibility of the af-

FIG. 1

fected parts. The illustrations show a few types of hand-scrapers which may be easily made. At *A* is shown a straight scraper with a hooked end which is used where there is plenty of room to work. At *B*, *C*, and *D* are shown curved scrapers which are useful for scraping around curves and corners. *C* and *D* are similar, except that *D* is curved both on the flat side and on the edge.

Tires

Seventy-five per cent of the trouble with tires is caused by neglect. Cuts and pin-holes are passed over as the merest trifles, yet their neglect is the cause of much of the rapid wearing out of the tires. A cut or hole, extending to the fabric, forms an excellent place for moisture or sand to accumulate. Sand, imbedded in cuts or holes, will gradually work in all directions, and, by slow abrasion, will cut the tread loose from the fabric, and soon the inevitable blow-out occurs. The frequent inspection of tires, and the immediate repair of even the smallest cut, will materially help in lengthening the life of the tire. The proper way to apply the filler or tire dough is to clean the hole or cut with gasoline. After it has dried, apply a good air-drying rubber cement. After the cement has dried, the dough is rolled between the fingers and then forced into the cut. It should be allowed to stand for some time, over night if possible, before again using the tire. If the cut or hole is too large, the best method, perhaps, would be the vulcanizing. Any motorist can

accomplish this work successfully, in a few minutes, by using any of the small vulcanizers on the market.

Substitute for Pipe Wrench

The pipe wrench may be broken or mislaid. Nothing else will do, as the work is round. Try this stunt. Procure two files and a piece of strong wire. Bend the wire in the form of a

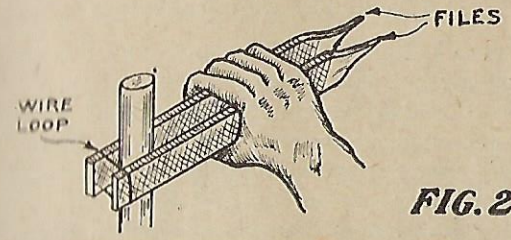


FIG. 2.

A SUBSTITUTE PIPE WRENCH.

loop large enough to be passed over the ends of the files and still allow enough room for the work to be slipped between. By grasping the other ends of the files, an enormous pressure can be exerted. The illustration clearly shows the method of using.

Winter Care of Batteries

A fully charged battery will never freeze in winter. But when the temperature hovers about zero, and the battery is in a discharged condition, there is the danger of the electrolyte becoming a compact mass of ice. Always keep

the battery fairly well charged in winter. If it is to stand idle, see that the plates are covered with electrolyte and keep in a fairly warm place. Give the battery a freshening charge about every month, so that abnormal sulphate cannot form. When the battery is in use, take care that the battery is given a charge immediately after adding water to replace evaporation, so that the added water will not have a chance to freeze.

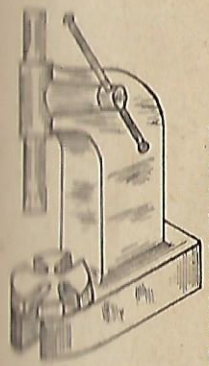
Cleaning Lamp Reflectors

Lamp reflectors can be cleaned by the use of wood alcohol and whiting. Dip a piece of absorbent cotton or some soft material in wood alcohol, apply a little whiting, and then wipe lightly over the surface of the reflector, working with a rotary motion from the back to the front. The reflector may then be polished in the same manner by using a soft, dry cloth. Care should be taken that too great a pressure is not exerted and that there is no grit present, so that the surface of the reflector is not scratched to any great extent.

Annealing Copper and Brass

When it is necessary to bend copper or brass of any appreciable thickness, good work cannot be done unless the material has been first softened or annealed. In its hardened state, the danger of cracking is always present when a sharp bend is made. The method of annealing is the reverse of that adopted in dealing with steel. The metal, whether wire, sheet or cast-

ings, is gradually brought to a red heat and then either air or water-cooled. Cooling in water gives the best results in most cases, but this is a point which can only be determined by experience. When the material has been annealed, it has become extremely soft and may be readily worked. When a great deal of hammering is done on the work, the metal again becomes hard due to the compression, and it may be necessary to repeat the process of annealing.



Arbor press.

Driving and Removing Bushings

When driving or removing bushings, a practice frequently noticed is to use a heavy hammer and to bang like blazes until the bushing is driven home or drops out. Frequently the bushing is found to have changed its shape to such an extent that it cannot be used. This is due to the fact that it was driven

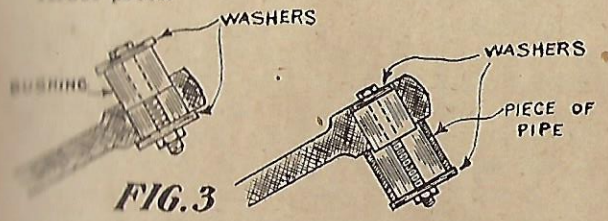


FIG. 3

A simple method of driving and removing bushings.

by a series of heavy blows instead of a constant pressure and the walls of the bushing have therefore buckled. Perhaps the quickest and best method of driving bushings is by the use of an arbor press, as shown in the illustration. By applying pressure to the long end of the handle, the power is greatly multiplied and transmitted to the driving shaft.

Such a machine, however, would prove too expensive for the small shop or private garage. A simple and effective method of driving and removing bushings is shown in the illustration. To drive, it is only necessary to provide two large washers and a bolt. Drawing up on the bolt drives the bushing home. To remove a bushing, a larger bushing or piece of pipe must be used on one end. The washer on the other end must be slightly smaller in diameter than the bushing. With this method, the bushing is driven straight, and there is no danger of buckling.

Hints on Nickel

If polish cannot be obtained for brightening nickel-plated surfaces, gasoline or kerosene will give good results.

When the nickel-plating has worn from brass parts, an unsightly appearance is the result. The nickel coating may be removed by applying equal parts of nitric and sulphuric acid with a brush. This solution acts rapidly upon the plating, leaving the brass visible in a short time. After the acid has been thoroughly washed away, a high polish may be imparted to the brass by buffing or polishing.

Marking Cotter-Pin Holes

There are awkward places on every car where a nut is cottered. The removal of the cotter-pin and the slackening off of the nut is a comparatively easy task. But—lining up the nut and the cotter-pin hole when replacing, is a task which often becomes very tedious. Before removing the cotter-pin, why not file a small line across the end of the bolt exactly where the cotter-pin hole is drilled? This, besides saving a great deal of time, aids much in lessening the disagreeableness of the task.

FIG. 4

FILE MARK DENOTES POSITION OF COTTER PIN HOLE.

Distributor Troubles

Distributors are often the cause of poor engine operation, knocking and misfiring. Where the distributor brushes are worn and dirty; where the breaker points are worn and pitted; where grease, oil or water have worked their way into the casing, and where wires are connected to the wrong terminals, erratic running of the motor is the inevitable result. The distributor brushes should always make good, even contact with the contact segments. Breaker points should always be true, bright and clean, and the gap should always be adjusted to the proper distance. The distributor case should always be kept free of grease, oil or water, both inside and out, so that

none of the connections should be short-circuited or grounded. Distributor wires should always be connected to their respective terminals so that each cylinder will fire in its proper order.

Home-Made Bunsen Burner

Perhaps one of the most useful tools around the small repair shop or private garage is the Bunsen burner. Its uses are manifold: the heating of soldering coppers, the melting of glue and babbitt metal, the supply of heat for annealing, etc. In fact, wherever a source of heat is required, it comes in to an advantage. The fact that only illuminating gas is necessary for its operation gives it an additional value. The illustration shows the construction of the Bunsen burner which may easily be made by the home mechanic. The base is made from a piece of scrap iron, the shape of which is immaterial. A hole is drilled in the center to half the depth of the base. Another hole is drilled from one edge to meet the center hole. A piece of tubing is threated into this hole to connect the gas hose. Into the center hole is threated a short piece of tubing, into which is soldered another short tube which is flatted on the upper end so that only a small slit remains for the passage of the gas. A piece of small pipe (about four inches long) is screwed on to the short tube in the center of the base. This pipe has a hole in each side, so placed that the lower edge of the holes will come slightly below the end of the flatted tube. A short piece of tubing, with similar holes, fits

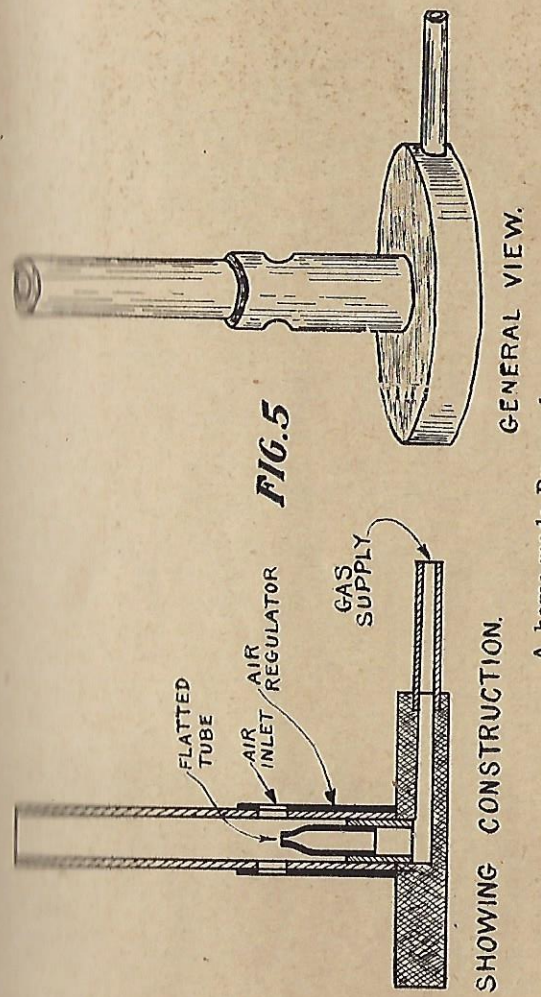


FIG. 5

A home-made Bunsen burner.

loosely over the long pipe. In operation, the gas enters through the lower tube and, in passing through the flatted tube, is given sufficient force to draw air in through the side holes. The loose tube on the outside permits regulating the supply of air by increasing or decreasing the aperture. The mixture of the air with the gas produces a hot, blue flame.

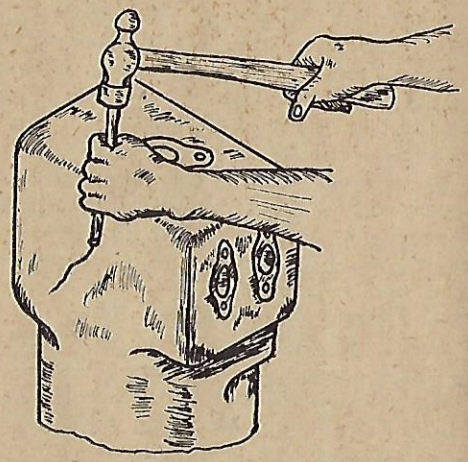
CHAPTER IV

Repairing Cracked Water Jackets

THE cracking of a water jacket is a decided misfortune. Carelessness, by permitting the cooling water to freeze, is the most frequent cause of cracks. Whatever the cause, an effort should be made to remedy the condition, if it is not too severe. A successful repair may save the expense of a new cylinder, or perhaps an entire motor, if the cylinders are cast "en-bloc." It must not be assumed that such a repair is an easy matter. In fact, attempts to repair a crack may result in aggravating the condition. But, as an engine with a cracked water jacket is worthless, it is worth while running the risk of wasting a little time in preference to laying out the price of new cylinders.

First, remove the cylinders. Then procure a cape chisel, as shown at *A* in the illustration. This chisel should be somewhat wider at the point than the widest part of the crack. See that the chisel is well sharpened, and with light blows from a hammer, cut a groove over the crack, trying to keep the crack in the centre of the groove. Cut to a depth of about one-eighth of an inch. Don't hurry the job and don't strike with too heavy blows, as the water jacket may have some thin places. If one crack branches off from another, extreme care must be used where the two cracks meet, as this point is weak. With a scraper as shown at *B*, scrape both sides of the groove until a dove-tailed groove is formed, as shown at *C*. Scraping will be found a slow pro-

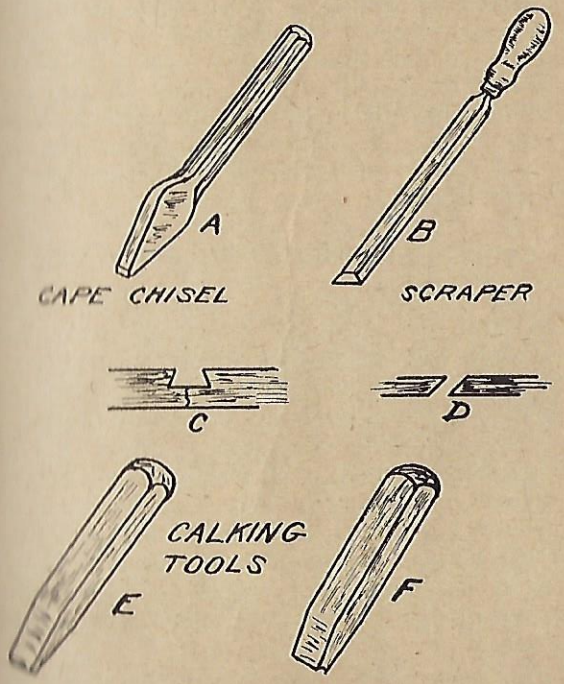
cess, but it is preferable to using a chisel as it is safer and produces a better finish. Then procure some soft copper about three-sixteenths of an inch thick and about as wide as the narrow part of the groove. Further soften this copper by heating it to redness and plunging it into cold



CUTTING GROOVE

water. Next, cut the copper to a length about three inches longer than the length of the crack, and bend it to correspond to the shape of the crack. The copper is then driven in at one end for a length of about an inch and is hammered into the groove with the ball end of a machinist's hammer until it holds tightly. The rest of the copper is then driven into the groove, but is not

hammered tight. If any joints must be made, it is advisable to file the ends of the copper, as shown at *D*, so that one piece slightly overlaps the other. After the copper has been driven into the



groove, it is spread by striking in the centre with a round-pointed caulking tool, as shown at *E*, which will cause the copper to spread out at the bottom. The spreading operation should be started from the end which was hammered tight

and should be worked around slowly. Do not work a short distance and then start from the other end, otherwise kinks will be formed. This operation should then be repeated, using a hollow-pointed caulking tool, as shown at *F*, which causes the copper to spread out at the top and entirely fills the groove. Any surplus copper may be filed off if desired. As copper expands more with the heat than cast iron, this method, if carefully done, will produce a permanent and leak-proof repair, even though the jacket becomes highly heated.

Separating Rusted Parts

Almost every garage or repair shop has its own little pile of useful junk—parts, which have outworn their original usefulness, but which may come in handy on some repair job. This pile is usually placed in an out-of-the-way place, generally exposed to the elements. When the pile must be consulted, it is usually found that the desired part is firmly attached to some other part by rust and cannot be separated without injury. Parts in this condition may be separated by boiling in linseed oil. This must be done where there is no danger of coming in contact with a naked flame.

To remove the rust, immerse the article in a strong solution of potassium cyanide, about ½ oz. to a wineglass of water. Clean with a paste composed of patassium cyanide, castile soap, whiting and water, applying with a toothbrush.

Plugging Holes

Where small holes in the body are to be plugged, the holes are generally threaded, screws or bolts are run in and filed flush. To guard against loosening, due to vibration, it is always best to use a screw or bolt which is not threaded for its entire length. By drawing up tight after the thread has ended, a firm, tight fit is assured.

Drilling Hints

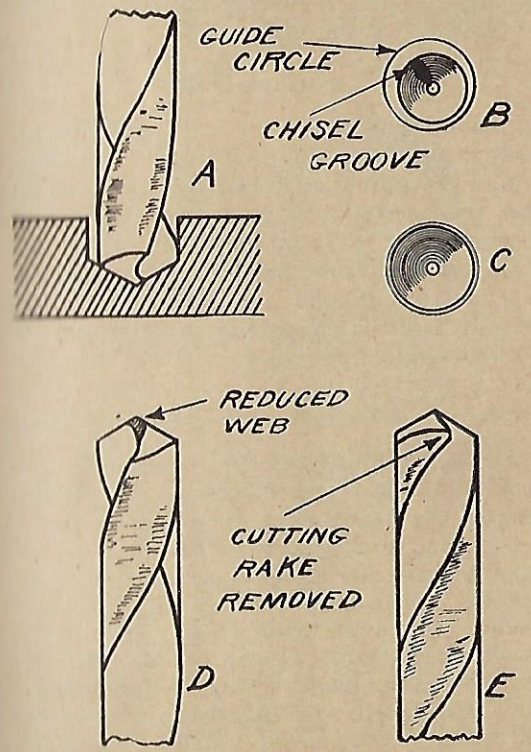
To drill a hole is a simple matter. But to drill a hole where it is wanted and of the required size requires a certain amount of knowledge and care. A hole may be marked off accurately with a centre punch and drilled. After drilling, it may be found that although the centre-punch mark had been in the proper place, the drill did not start on the mark. Or the hole produced may be much larger than the drill. To guard against such mishaps, the drill should be properly ground both "lips" at the same angle and both of the same length. If one lip has a different angle from the other, the side having the largest angle will be forced to do all the work, with the result that the cutting edge soon wears off. If one lip is longer than the other, the drill will cut oversize. The outside diameter of the drill does not determine the size of the hole that will be produced the length of the lips is the deciding factor. A drill always cuts a hole twice the size of the longest lip. Consider the half-inch drill. If ground correctly, both lips will measure ¼ of an inch; and twice ¼ equals ½. But if one lip

should measure 5/16 and the other 3/16, then the hole will be twice 5/16 or 5/8 of an inch. At *A* is shown the action of such a drill. The machinist often makes use of this principle. If he finds it necessary to drill an odd-sized hole, he grinds a drill slightly one-sided so that it will cut oversize.

A large drill always has a tendency to run off the centre-punch mark, but it may be drawn back in a simple manner. After placing the centre-punch mark, use the mark as a centre to draw a circle with the dividers. This is known as a guiding circle and should be as large as the hole to be drilled or slightly larger. Start the drill, and after it has cut a depression, look to see if it is cutting concentric with the circle. If not, as shown in the sketch, cut a small groove with a round-nose chisel in the wide side, as at *B*. Then cut a little deeper with the drill and look again. It will be found that the drill has moved toward the side with the groove, as at *C*. After the drill is once started concentric with the circle, the hole may be drilled through.

Drilling holes with a breast drill or hand brace is hard work, consequently any method which may make it easier is always welcome. The following method will cause the drill to "bite" with surprising rapidity. Grind the drill in the usual manner. Then grind away in back of each cutting edge, as shown at *D*, thus reducing the width of the web. This web does not cut, but it grinds its way into the metal; therefore the shorter it is, the less pressure will be required to make the drill cut.

Drilling sheet iron or soft metals such as copper or brass is ticklish business and often results



DRILLING HINTS.

in broken drills or bruised knuckles. This is due to the fact that the drill has a tendency to draw

wheels wobble. Here the grinding effect is only present at certain portions of the revolution, producing the flat spots at these points.

Care of Tops and Upholstery

The matter of cleaning and caring for tops and upholstery is one which should receive serious consideration. In the higher priced cars, the tops are of either leather or mohair; while in the lower priced, imitation leather or mohair substitute is used.

Gasoline should never be used for cleaning leather. Use a little ammonia in water to remove dirt and follow by a brisk rubbing with a clean woolen or flannel cloth. Always rub until dry. The top should never be folded until perfectly dry, as any moisture which remains in the folds, will form a mildew and in time, will form leaks and unsightly spots. Keeping the top open is beneficial, as it keeps it well stretched and smooth. Where the leather has become shabby, it may be rejuvenated by a brisk rubbing with either linseed or sweet oil. When a more careful treatment is desired, the application of a reliable leather dressing will prove beneficial.

Mohair tops should be frequently brushed and dusted. Grease or oil stains may be removed by means of a sponge and soapsuds.

Where the upholstery is of leather, the same treatment as used for tops may be applied. Dust may be beaten out of cloth upholstery with a stick or carpet beater and then whisked off. Grease and oil may be removed with a solution of luke-warm water and Ivory soap. Where a more drastic cleanser is desired, either gasoline or any of the solutions on the market will do.

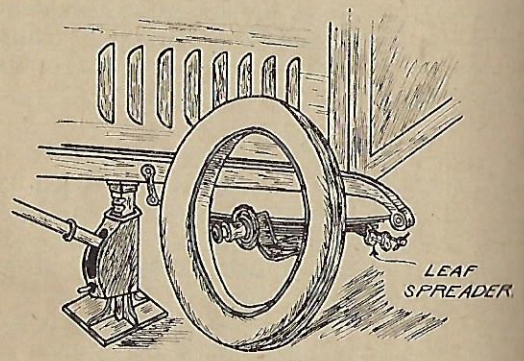
It is inadvisable to attempt to clean the upholstery in the higher-priced cars. The fine texture of the upholstery requires very careful treatment and an experienced cleaner should do the work. Ordinary methods of removing spots generally result in unsightly discolorations of the fabric. Of course, where but a small spot is to be removed, it seems ridiculous to employ a cleaner. A little gasoline or cleaning solution on a rag, wiped lightly over the spot, may eradicate the eye-sore to a great extent.

Springs

The springs are to an automobile what the gristle is to the cushioned parts of the body. Nature takes upon herself the task of oiling and lubricating the body so that the shocks and jars of our everyday movements may be lessened to a great extent. The fact that the automobile is not self-lubricating, imposes this task upon the owner.

Resiliency and strength are essential qualities in a spring; qualities which are obtained by the practice of incorporating a series of spring leaves in one unit. Each leaf is an independent spring in itself, adding its strength to its neighbors until the required strength and resiliency is obtained. When a car is carrying a heavy load, it will be noticed that the springs, instead of being bow-shaped, are well straightened out. Each individual leaf slides over its lower neighbor until all assume the same shape, the lower leaf sustaining

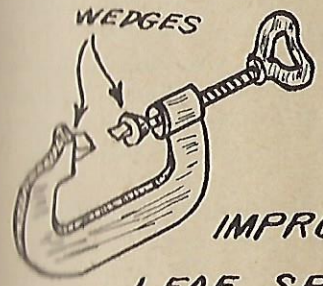
the entire burden. When spring leaves are obtained from the factory, they are quite smooth and well lubricated. In the course of time, however, they become rusted, their free-sliding qualities are gone and as these qualities absorb the shocks and jars of the road, the comfort of riding is lessened. Not only is comfort sacrificed, but there is the danger of the breaking of the leaves.



CORRECT METHOD OF SEPARATING LEAVES FOR LUBRICATING.

Springs require but little attention. The spring clips must be kept tight; the spring shackle bolts well oiled. Once a season, they should be thoroughly lubricated with a good grade of graphite grease, after which oiling each month will be sufficient. The job is best done by jacking up the car so that all weight is removed from the springs, and then loosening the spring clips. The leaves are pried apart with a thin point, just far

enough so that the lubricant may be spread between with a thin knife, or if oiled, so that the oil may readily flow between them. Do not take the chance of breaking the springs by using a heavy chisel and a hammer. Such treatment often results in permanent sets and bends, and if too near the end of a leaf, a broken spring may be the penalty. A spreader for spring leaves may easily be made from an ordinary C clamp. Two wedges are soldered on, as shown in the illustration, taking care to bring them in line as nearly as possible.



IMPROVISED LEAF SPREADER.

Neglecting the lubrication, and allowing the dry springs to rub over each other, is the cause of many of the squeaks or "canaries" that assail the ears.

When a spring leaf is broken, the only reliable remedy is to install a new one. Although a car may be driven with a broken spring leaf, it must be remembered that more work is placed upon the others and greater breakage may be the result.

Broken "Lights"

There is nothing which mars the appearance of a car more than broken or scratched celluloids. The best remedy, of course, is to install new "lights"; but at times, such a course is not possible and a makeshift must be resorted to. Celluloid is a soft material and in time its surface becomes covered with scratches. These scratches refract the light, passing through, at an angle, and the celluloid assumes a translucent or cloudy effect, allowing light to enter but cutting off the view. Filling such scratches will improve both the appearance and the usefulness of the window.

Where the scratches are very fine, a thin coat of ether or acetone may be applied and allowed to dry in the air. For heavy scratches, a thin coat of water-white varnish or shellac is advisable.

When the "light" has been broken, it may be cemented together by a mixture of three parts of alcohol and four of ether. The torn edges are painted until the material softens; they are then pressed together and the pressure allowed to remain for at least twenty-four hours. By lowering the top, it becomes a simple matter to apply the pressure required.

Cooling System

An unobstructed and vigorous circulation of the water in a cooling system is necessary for the smooth running of the car. Fortunately, it is an easy one to take care of and repair.

The forced circulation method is perhaps the most commonly used. The water is taken from the lower part of the radiator by the pump; is forced through piping around the cylinder walls and combustion chambers, and flows back into the top of the radiator. Passing through the many tubes of the radiator, which are comparatively cool due to the currents of air drawn through by the fan, the heated water is cooled sufficiently when it reaches the bottom of the radiator so that it may again be passed around the cylinders.

The troubles caused by an inefficient cooling system are manifold. Lack of water in the radiator, due to leakage, will cause overheating and smoking of the engine; laboring and groaning and at times the seizure of the pistons in the cylinders. Lack of water may be caused by leakage in the radiator, the pump or the piping, or by a leaky, open or broken drain cock. Obstructed circulation may be caused by a broken pump or pump driving connection, by waste or foreign matter lodging in the pump or the piping or by a piece of hose lining which has become loose and acts as a check valve. An obstruction in the circulation, elsewhere than in the radiator, will cause the bottom of the radiator to remain cool while the top may be boiling hot. When the cause of the trouble has been located, it should be immediately remedied.

A trouble, liable to be mistaken for radiator circulation trouble, is that due to the slipping of the fan belt. The fan, therefore, does not run at full speed; the radiator tubes are not properly

cooled and the surplus heat of the water is not absorbed. Most cars have an adjustable fan bracket, by which the proper belt tension may be maintained. If the belt is broken or lost, the fan may be driven by a piece of strong cord until repairs can be made.

Generally, the pump needs no adjustment. At times, however, a leak may occur around the packing nuts. If tightening the nuts does not remedy the trouble, the packing must be replaced. Where the packing provided for the purpose is not available, a thick, heavy piece of string, well coated with graphite or graphite grease, will answer the purpose. When putting on packing, it should always be wound in the same direction that the nut turns; otherwise, tightening the nut will loosen the packing.

An excessive amount of mud or dirt on the outside of the radiator will naturally lessen its cooling qualities. Mud or dirt may be removed by washing with a hose. The water should be under moderate pressure and should be applied to the back of the radiator. Where grease or oil form part of the obstruction, gasoline applied with a brush or swab will be found effective.

The presence of scale or sediment in the radiator is indicated by an unusually high temperature of the radiator. This scale or sediment may be washed out, applying the hose at the filler cap. If this method does not remove all of the foreign matter, a solution of washing soda may be used—about two pounds of soda to a gallon of water. Thoroughly drain the system and then allow the solution to remain about eight or ten

hours. When drawn off, the system should be washed with water, until the water that flows from it is clear. It is good practice to thoroughly clean the cooling system about once a year.

Remedies will readily suggest themselves when broken clamps, missing nuts and leaky hose are found. Friction tape, wrapped tightly around leaky hose, makes an emergency repair until a thorough job can be done.

Anti-Freeze Solutions

As is well known, pure water is the best cooling agent for use on the automobile engine. But as the weather becomes colder, its one great disadvantage may be forcibly impressed upon the car-owner by the freezing of his cooling system. The high freezing point of water makes it necessary to provide some means by which the danger of a frozen cooling system may be avoided.

A good anti-freezing compound should possess the following qualifications: it should readily combine with water; it should not evaporate rapidly; it should have no injurious effect on the metals or rubber used in the cooling system; and it should be cheap.

A solution of calcium chloride was at one time widely recommended. It answers the purpose, but is injurious to the metal work unless chemically pure. The difficulty of obtaining chemically pure calcium chloride make its use inadvisable.

Denatured alcohol is effective in lowering the freezing point of water and is not injurious to the metal work or the rubber. But it has the dis-

advantage of quickly evaporating out of the mixture. Glycerine is effective and does not evaporate readily, but is decidedly injurious to rubber hose.

Probably the best solution is a combination of water, alcohol and glycerine. When used with alcohol, the quantity of glycerine is so small that there is practically no injurious effect on the rubber hose. A solution composed of 70% water, 15% alcohol and 15% glycerine is effective in any but the most severe climates, as it will not freeze until a temperature of five degrees below zero is reached.

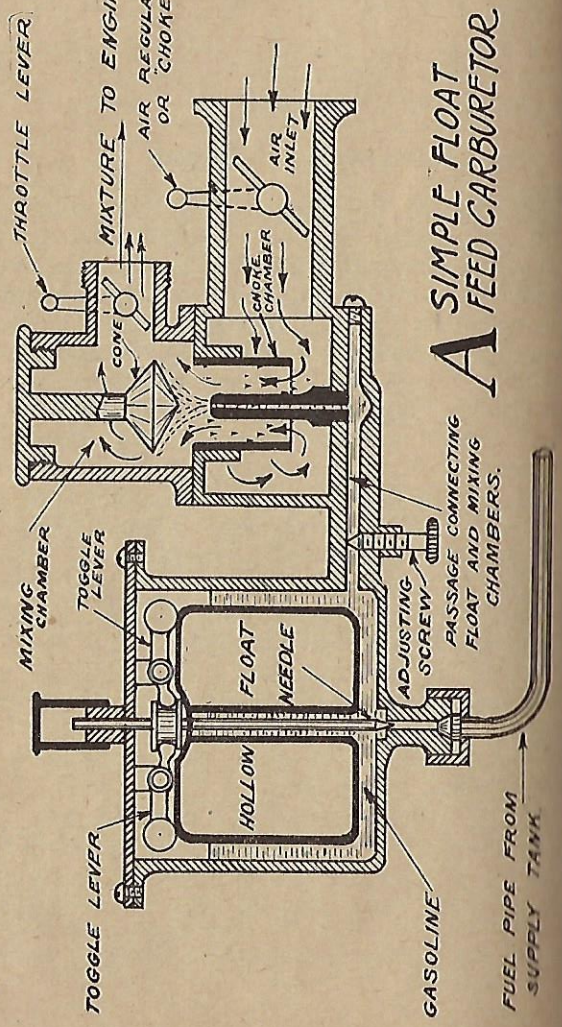
CHAPTER V

Carburetor Adjusting

THE carburetor is that part of the automotive mechanism which is rarely understood by the layman. Its formidable appearance, no doubt, has done much to further this ignorance, yet it is really a simple piece of mechanism. The float feed carburetor has become the standard equipment, because of its many advantages over the simpler types. Stripped of its frills and furbelows, it consists simply of two compartments: a float chamber and a mixing chamber.

At A, in the illustration, we have a simple float feed carburetor with the float chamber carried to one side of the mixing compartment. The float is a hollow drum of sheet metal. The needle valve is separate and operates through the center of the float by a combination of toggle levers. The fuel line from the supply tank is connected to the bottom of the float chamber and contains a gasoline adjustment valve. The mixing chamber contains the jet or spray nozzle and an inlet for the air.

The sole duty of the float is to maintain a predetermined level of gasoline in the carburetor. This level is generally a small fraction of an inch (varying from perhaps one-sixteenth (1/16) to one-eighth (1/8) of an inch, according to the type of carburetor) below the jet or



A SIMPLE FLOAT FEED CARBURETOR

nozzle opening. When the gasoline flows into the float chamber, the float rises in the liquid and exerts an influence on the toggle levers, which force the needle valve into its seat and the supply of gasoline is cut off. When the piston makes a suction stroke, a certain proportion of fuel is drawn from the spray nozzle and the level in the float chamber accordingly falls. The falling of the float again actuates the toggle levers, which raise the valve from its seat and fuel again enters. When the motor is running and using fuel, the float is continually rising and falling, thereby maintaining the approximate gasoline level in the float chamber.

In the mixing chamber, the air is forced to pass close to the spray nozzle because of the choke chamber; a mushroom deflector tends to break the solid column of gasoline drawn from the jet and thereby affords an opportunity for considerable surface evaporation. The action of the carburetor is simple. When the engine is cranked, the suction stroke of the piston draws air into the carburetor through the air intake. This air rushes around the spray nozzle and draws a certain amount of fuel from the jet. This fuel comes forth in a sort of a spray and rapidly vaporizes, forming with the air a mixture which is capable of igniting in the combustion chamber. An adjusting screw is generally placed in the passage between the float and the mixing chamber so that the amount of gasoline admitted through the spray nozzle may be regulated. The throttle valve, placed in the mixing tube above the spray nozzle and con-

maintain the proper level in the float chamber. The needle valve will, therefore, remain open and fuel will be constantly admitted, causing a dripping of the carburetor. A leaky metallic float should be soldered, using a minimum of solder so that the weight of the float will not be appreciably increased. A cork float which has become gasoline soaked should be thoroughly dried. It may then be varnished with shellac, allowing the shellac to dry for about twenty-four hours. Where the needle valve does not seat properly, and there is no sediment in the seat, the only remedy is to replace or regrind. If the valve is of steel, use fine emery and oil and grind to a tight seat. If of brass, tap the valve lightly in its seat and then grind with oil. A mixture of Bon Ami and water has been found to give good results. Dripping may also be caused by a too high adjustment of the float. The float is not lifted sufficiently by the incoming gas to properly close the float valve and gasoline therefore escapes from the spray nozzle. The obvious remedy is to lower the float, just a trifle at a time, until the proper height is reached.

Sometimes the flow of mixture from the carburetor may be cut off or become erratic due to a jammed float. In "tickling" the carburetor, the float may have become jammed in its seat. If, upon inspection, the needle valve is not bent, the float will have been loosened by its removal and will again work properly upon its installation. If the needle valve is bent, great care must be taken in straighening the spindle. The metal

should be placed upon a block of hard wood, another block interposed, and the spindle gently tapped with a hammer.

Clogged fuel lines and carburetor passages are also the cause of stalling and erratic action. It is well to periodically drain the carburetor, thus removing much of the sediment. An obstructed spray nozzle often causes misfiring at high speeds, as it decreases the amount of fuel delivered to the mixing chamber, and the cylinders therefore receive too lean a mixture.

A lean carburetor mixture—too much air and too little gasoline—is caused by a poor float valve, needle valve or adjustment, clogged spray nozzle or clogged carburetor passages and fuel line. A mixture that is rich—too much gasoline and not enough air—may be caused by a float which remains open; poor needle valve seating; leaky or gasoline-soaked float; or an air valve which will not open sufficiently, due to a too strong spring tension.

Squeaks and Rattles

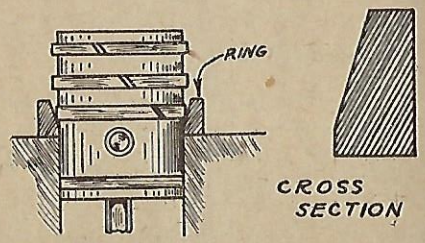
Some of the common causes of squeaks and rattles may be classed as follows: a body or dash rub, which can be remedied by tightening the bolts; a body and frame rub, which can be eliminated by tightening the bolts, or if it still persists, a packing of leather well covered with graphite grease may be bolted down at various places between the body and frame. A loose speedometer shaft if often the cause of much squeaking, an evil which can be readily eliminated by simply tightening the connections. Un-

lubricated springs and glazed brake bands are frequently the offending members and sometimes a valve stem running dry in the guide may be the cause of an elusive squeak.

In the rattle family, loose fenders and hoods are perhaps the most flagrant offenders. Loose door catches and hinges contribute their share and may be silenced by a tightening and the application of a drop or two of oil. The brake linkage may need an adjustment and tightening up; there may be play in the gear shaft connection which should be tightened or a new pin and bolt and nuts installed. Play in the spring shackle bolts may cause a rattle, advising a replacement of the bolts or a rebushing. Tie rod bolts and loose steering knuckle pins should either be replaced or tightened.

Compressing Piston Rings

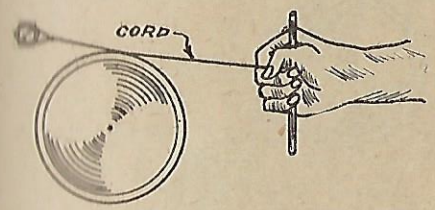
When inserting pistons into their cylinders,



USING METAL RING TO COMPRESS PISTON RING

it is necessary to compress the piston rings so that they will enter with the pistons. There are

many methods of doing this, but perhaps the best and quickest is shown in the illustration. A ring of metal, preferably, though not necessarily of brass, is turned on a lathe. The bore of this ring is made of the same diameter as the cylinder bore for a short distance, say about one-quarter inch. From this point the bore is tapered, so that at the larger end the bore has increased about one-half (½) inch. The width of the ring should be about one and one-half (1½) inches. In use, the ring is placed directly over the cylinder with the small end down. The piston, with its rings inserted in their grooves, is then pushed through. As the piston passes through the ring, the piston rings are gradually compressed to enter the cylinder. For garage work, a number of such rings, of sizes to suit various types of motors, will soon repay the expense in their making.



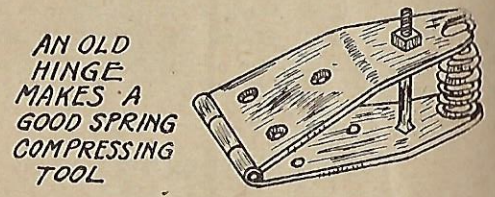
COMPRESSING RING WITH A CORD

The car owner, however, may not care to bear the expense of such a tool, in which case either of the other methods will do very nicely. One of the cylinder head bolts is loosely placed

metal is formed into sort of a cylinder and may readily be tapped. The shank of the punch should be of the same diameter as the standard tap drill.

A Home-Made Valve Spring Compressing Tool

A simple valve spring compressing tool may quickly and easily be made from an old hinge. A square hole is cut in one leaf for the head of a carriage bolt, while a round hole is cut in the



other leaf. A slot is cut in each end of the hinge to slip over the valve stem, as shown in the illustration. Turning down the nut will compress the spring, which may be left in the compressor until it is to be replaced.

Loose Fan Belts

Sometimes a motor will overheat for no apparent reason and the motorist generally suspects everything but the part at fault. A common cause of motor overheating is that of a loose fan belt. The slipping of the belt on the pulleys, either because of looseness or because of being oil soaked, causes the fan to be driven at a much

slower speed than is intended and overheating is the result. On most motors, the belt tension can be adjusted by setting the belt shaft higher, thus lengthening the distance between the pulley centers and taking up the belt slack. In adjusting care should be taken that the belt is not drawn too tight, as there is the probability of drawing one of the pulleys out of line, causing the belt to run against the flanges and fray at the sides. There should be just enough slippage so that the weight of the hand will move the fan, but not spin it. With such an adjustment, there will be no appreciable wear in either the belt or the pulleys.

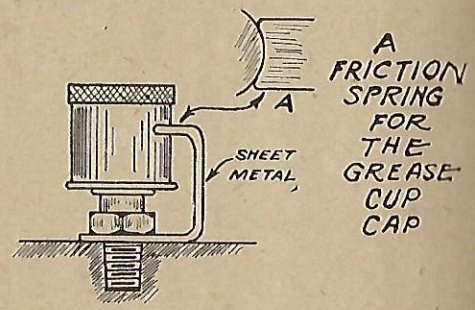
Muffler Explosions

Muffler explosions while the engine is running indicate a missing spark plug. When the spark does not jump regularly across the points of the plug, the unburned gases of that cylinder pass into the exhaust pipe. When this is immediately followed by a flaming hot exhaust of the succeeding cylinder, this unburned mixture is ignited. The explosion actually takes place in the exhaust pipe, though the noise reaches the ear from the muffler pigtail. As it is necessary for a combustible mixture to pass into the exhaust pipe in order for a muffler explosion to occur, such a combustible charge is possible only when the ignition system has failed to ignite it when it was in the cylinder. If such explosions occur, a missing spark plug may be suspected. Such explosions may also occur when one coasts down a hill with the spark retarded and the ignition

switched off. As soon as the ignition is again turned on, a muffler explosion is liable to occur. With a retarded spark, the charge is still burning when the exhaust valves open and the accumulated gases in the muffler are ignited. With an advanced spark such a danger is lessened.

To Prevent Loss of Grease Cup Caps.

Grease cup caps sometimes have the annoying habit of rattling loose and falling off. To overcome this difficulty a piece of sheet metal may



be bent as shown in the illustration. The longer end is drilled to pass over the thread of the grease cup. The shorter end is filed to fit the side of the cap, as shown at A. This produces sufficient friction to prevent the cap from working loose through vibration.

CHAPTER VI.

All About Brakes

UPON the efficiency of the brakes depends the safety of the occupants of a motor car. Brakes which are independable are worse than none. It therefore behooves the car owner to keep the brakes in order.

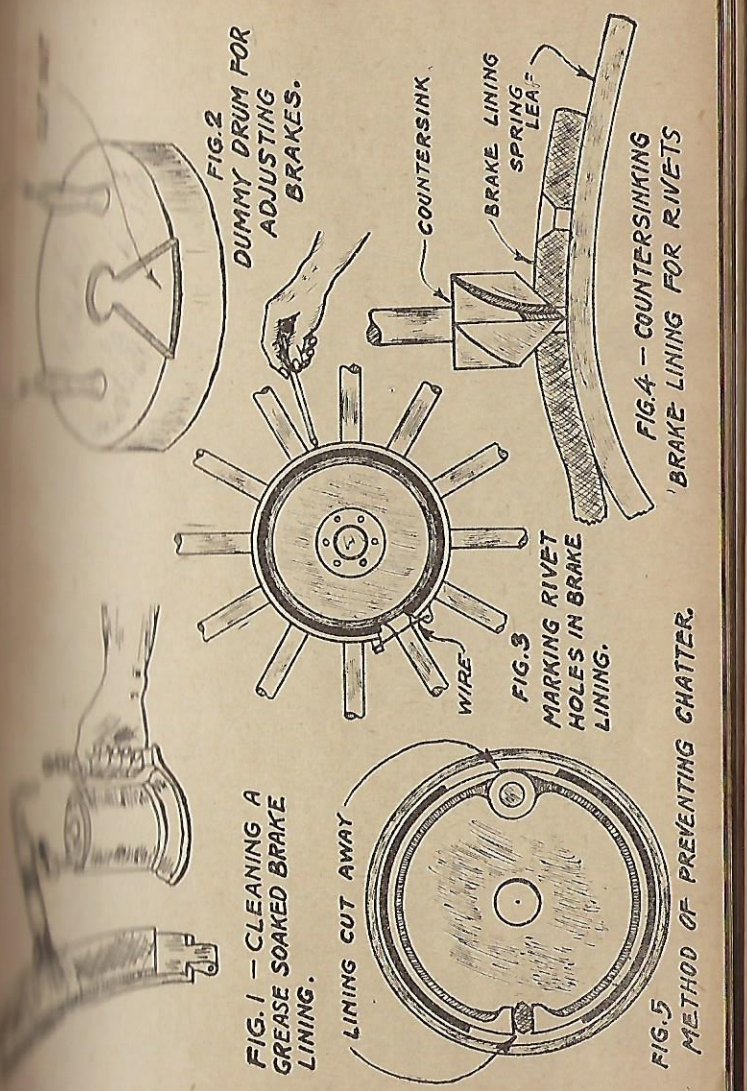
The brakes in general use are of two distinct types: the internal expanding and the external contracting, named according to their method of operation. The former operates by creating a frictional resistance on the inside of the brake drum, while the latter operates on the outside of the drum.

When the brakes fail to hold the car, it is a fair indication that they need adjustment; though not always, as oil or grease on the friction surfaces will prevent their holding. Washing with kerosene or gasoline will remove the grease from the surface. If, however, the grease has worked into the fabric, it may be removed as shown in Fig. 1. A blow-torch is applied lightly to the surface of the lining, moving it continually so as not to char the fabric. At a certain temperature, the grease will ooze to the surface, when it may readily be removed with a rag steeped in kerosene or gasoline. Care must be taken that the naked flame has been removed to a safe distance or extinguished.

If the brakes fail to hold after cleaning, they will need adjustment; provided, of course, that the linings are not worn. Before attempting any adjustments on the brakes themselves, the tie rods should be shortened. Then, if there is no improvement, the brakes should be examined and the necessary adjustment made. As there are many methods of providing for adjustments, each of which appears quite simple after a little study, it will be unnecessary to go into details. Suffice it to say that where there is more than one point of adjustment, each point should be taken up a little at a time until the pressure is evenly distributed.

After adjusting each brake separately, test them to see that each is exerting the same pressure. This may be done with the car "jacked up" and the gears in a neutral position. By slowly moving the brake lever toward the "On" position, the brake which first takes hold may readily be found. Unequal pressure on the brakes will cause the car to skid to one side when the brakes are applied. It should also be noted that the brakes release fully when the lever is in the "Off" position, otherwise the binding of the brakes will cause a rapid wear of the brake lining and the overheating of the engine. When adjustments fail to prove effective, it indicates that the linings have worn thin and require replacement.

As the adjusting mechanism of most brakes is not readily accessible, it is necessary to remove the wheels. When a heavy wheel must be removed and replaced several times while mak-



ing adjustments, considerable time is consumed, not to mention the "elbow grease" required. When a great amount of such work is done, a number of dummy drums, as shown in Fig. 2, will be found useful. These are of sizes to suit the cars worked upon. A section is cut away so that the action of the internal brake may be noted.

Brake lining can sometimes be secured ready to apply. If not, it must be cut and the rivet holes located to suit the band. The best way to measure the length is to place the lining loosely in position, cutting off so that there is a slight overhang on each end. It is important that the rivet holes be accurately located so that the lining will lay evenly in the band. To mark the holes, lay the wheel on the floor and place the lining and the band in position, drawing the latter together with wire or a clamp. With a pencil, mark the lining through the holes in the band, as shown in Fig. 3. The holes may be punched with a belt punch or may be drilled, after which they are countersunk to suit the rivet heads. A sharp countersink must be used in order to prevent the tearing of the fabric. Care must be taken that the countersink does not cut too deeply or perhaps go all the way through, thereby not leaving sufficient hold for the rivet head. A good method is to place the lining on an old spring leaf. As the point of the countersink strikes the spring leaf, it will stop cutting, thus making each hole of the proper depth. (Fig. 4.) The rivet heads are always placed in the lining, the riveting being done on the band. With

the rivet head placed on a piece of iron or a bolt held in a vise, the rivet should be drawn tight with a rivet set. Another head is then formed on the rivet with the ball end of a hammer. On the external brake, the riveting should be started at one end, working toward the other. On the internal brake, the riveting is started at the center, working outward both ways. After the riveting is completed, any portion of the lining which overhangs on the ends should be cut off.

A squeaky brake is caused by dirt clogging the pores in the surface of the brake lining. The lining should be cleaned with kerosene or gasoline, using a stiff brush.

The internal expanding brake is sometimes in the habit of chattering. Frequently this is caused by the brake lining extending over too large a portion of the brake drum. The remedy is to cut away the lining, as shown in Fig. 5. The portion of the brake shoe around the operating cam is springy and takes hold with a series of jumps. The lining around the pivot pin has a tendency to bulge outward when the shoe is expanded, producing a similar effect. Cutting away the lining at these two points will usually remedy the annoyance, and still provide sufficient friction surface to stop the car.

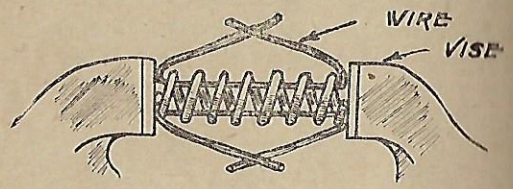
Cotter Pins

When a cotter pin is slipped into place, the ends should be spread just enough to prevent the pin from slipping out. There is no necessity for bending the ends against the bolt or nut. When the ends are bent considerably, it is more

difficult to straighten them for later removal. There is also danger of the ends breaking off while the part is in service, with a very probable result that the cotter will slip out.

Replacing Strong Coil Springs

Great difficulty is often encountered in replacing strong coil springs which must be compressed, especially the clutch spring. This difficulty may be removed by using the method shown in the illustration. Two pieces of wire are inserted in the spring, as shown, and the spring is compressed in a vise. The wires are then drawn tight and twisted together, so that there is no danger of the spring expanding. The spring can then be set in place, the wires cut, and the job is done.



COMPRESSING A HEAVY SPRING.

Tire Hints

Light and heat are the worst enemies of rubber. Spare tires should be kept in a dark, cool place and should be protected from dust and moisture.

Talc should be dusted over shoes and tubes. If tubes are folded, they should occasionally be opened and refolded in order to prevent the formation of creases.

Keep spare tires in their casings. A dark surface will absorb more heat than a light one—therefore have casing of tan, gray or white color. Occasionally change the position of the casing in the holder, so that the straps will not cut into the bead.

When crossing broken stones, withdraw clutch and coast over. Driving the car over such a surface will force the tires against the sharp edges, and cutting it more liable to result than if the tire rolls over them.

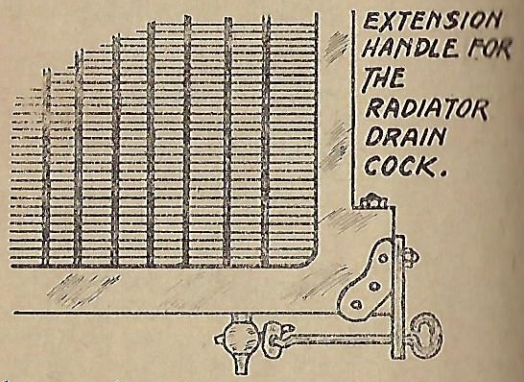
Never apply the brakes with such force that the wheels will slip. If wheels are locked, much of the retarding effect is lost and much rubber is ground from the tires. On muddy roads or pavements, all control over the car may be lost.

Wet rubber cuts much more easily than dry. In wet weather, sharp stones, car tracks or stray bits of glass or metal may cause serious damage to tires, while in dry weather they might have but the least effect, if any. A careful driver avoids them at all times, but is especially cautious when the roads are wet.

Extension for Radiator Drain Cock Handle

The draining of the automobile radiator, due to the position of the drain cock, is generally a task for a contortionist. During the summer, the necessity for draining is not so frequent and the inaccessible position of the drain cock is of

little concern. But in winter, the safety of the radiator often depends upon frequent draining and the position of the drain cock is then a source of never-ending annoyance. This inconvenience may be easily remedied. A hole is drilled in the handle of the drain cock. One end of a piece of iron rod is inserted and bent into an eye. The rod is carried beyond the frame



and passes through a support of flat iron which is bolted to the frame, as shown in the illustration. It is well to have the hole in the support but a trifle larger than the iron rod so that no annoying rattle will result. A handle can easily be formed on the end of the rod, and as this will be in a readily accessible position, the drain cock can now be opened without any difficulty.

Squeaky Cylinder

A squeaky cylinder indicates dry piston rings, piston and cylinder walls. The simplest method

of remedying a squeak within the cylinder is to inject oil through the spark plug openings or the petcocks. New engines are often fed oil through the carburetor. When only one or two cylinders are dry, there is no necessity for adding extra oil to the crankcase, as this would perhaps cause an excessive oil consumption by the other cylinders.

Removing Tight Nut

If a nut cannot be removed by ordinary means, try heating and then apply the wrench. Or try pouring kerosene on the nut and bolt and allow it to remain for about an hour. If the nut is still obstinate, drill holes in the nut and split it with a chisel. This method will save the threads of the bolt or stud.

Noise in Rear Axle

Noise in the rear axle may be due to several causes. The construction of some differentials naturally produces a humming sound. But if a harsh grating sound is heard, or, in the case of some cars, any noise whatsoever, there is some defect which will require immediate attention. Some causes are lack of oil, use of the wrong grade or a poor grade of oil, gears out of alignment, chipped, burred or broken teeth, or, in the case of an old car, worn gears may be the cause of the noise. If the insertion of new lubricant in the differential housing does not silence the noisy action, the gears should be inspected to see that the teeth are not worn too much and that

CHAPTER VII

Adjusting Wheel Alignment

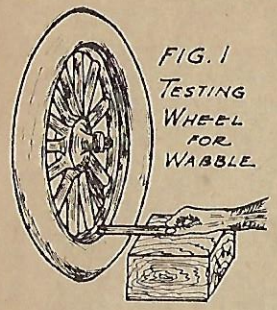
BY wheel alignment is meant the position occupied by the wheels in relation to each other and to the body of the car. Poor alignment not only makes steering difficult, but has a bad effect on the tires. Therefore, check up the wheel alignment frequently.

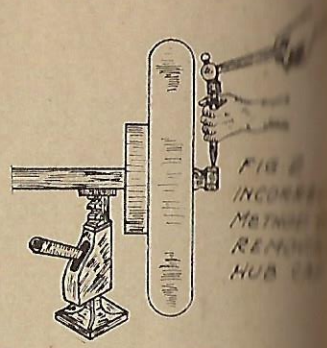
The first thing necessary is to inspect the wheels themselves. Lost motion in the front wheel bearings can be detected by jacking up the car; and by grasping the wheel at the top and bottom, try to rock it in a see-saw fashion. A wooden wedge should be driven between the front axle and the spindle, so that lost motion in the knuckle will not be mistaken for play in the wheel bearing. Should lost motion exist in the wheel bearing it should be removed by tightening the adjusting nut inside the hub cap. The rear wheels may be tested by jacking up the car and grasping the hub cap, work it up and down in order to detect any play in the bearings. If there should be play the bearings should be adjusted. After all lost motion has been removed the wheels should be tested for wobble. This is done by jacking up the car and holding a stick or pencil close to the wheel rim while the wheel is slowly revolved (Fig. 1). A block of wood

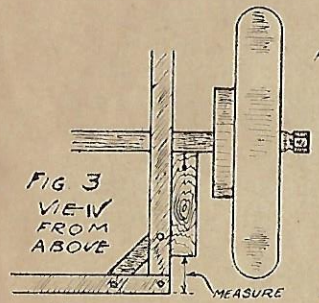
will steady the hand, and any wobble will be easily seen, as the space between the stick and the rim will vary. Incidentally, it may be mentioned that if the tires wear unevenly (in high and low spots), a wobble may be suspected. If the wheel rim has merely shifted on the felloe, it may easily be remedied by placing a block on one side of the felloe and striking with a hammer.

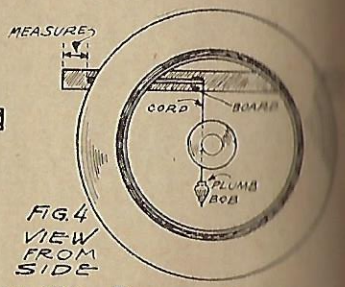
A frequent cause of wobble in the rear wheels is caused by an incorrect method of removing the hub caps as shown in Fig. 2. Here, the axle is jacked up while the hub cap is removed by means of a drift struck with a hammer. A wrench is better, even though is may be necessary to strike it, as the blow will then exert more of a twisting effect. In the example shown, the rear axle may be easily bent by the force of the blow. The important point, however, is to avoid jacking up the car until the hub cap has been loosened.

Having adjusted the wheels, the rear axle should be tested to see if it is square with the centre line of the car. Procure a narrow board, with parallel sides and carefully squared ends. To one end of the board attach a cord carrying a plumb-bob or weight. With one edge of the board placed against the frame, slowly move it forward until the cord just touches the rear axle. Then measure the distance from the end of the frame to the back end of the board. This is shown in Figs. 3 and 4. After the measurement has been taken on one side, try the other.









METHOD OF LINING UP REAR AXLE

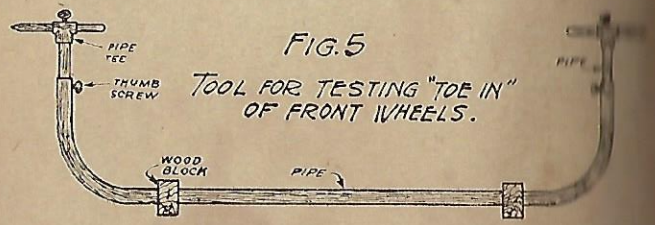


FIG. 5

TOOL FOR TESTING "TOE IN" OF FRONT WHEELS.

If they do not tally, it shows that the rear axle is out of square. The spring clips should be loosened and one side of the axle moved backward or forward as required. On most cars it is possible to move the axles about one-fourth of an inch. At the same time, measure the distance from the sides of the frame to the spokes of the wheels. If the measurement is not the same on both sides, the rear wheels will not follow in the same track as the front. This may readily be seen when driving on a damp road.

After the rear wheels have been put in good shape the front should be tested. Measure from centre to centre of the wheel hubs on each side and adjust the front to make them even. Then measure for the "toe-in" of the front wheels. "Toe-in" is necessary because the wheels have a tendency to "toe-out" when the car is in motion. Unless properly toed-in, the treads of the tires will grind. To measure for toe-in, the measurements are taken on the felloes at the height of the hub, both in front and in back of the axle. In new cars, the distance between the front of the wheels is generally from $\frac{1}{4}$" to $\frac{3}{8}$" less than in the back. With old cars, the distance should be increased somewhat, as the steering knuckles become loosened through wear. The "toe-in" can be adjusted by adjusting the length of the steering knuckle tie-rod, from one steering knuckle to the other, and should be done with the wheels on the ground. A handy tool for testing toe-in is shown in Fig. 5. This tool may be easily made from pipes and pipe fittings.

come so worn as to expose the rivet heads (which had been properly inserted), new brake lining should be installed.

Carrying Extra Inner Tube

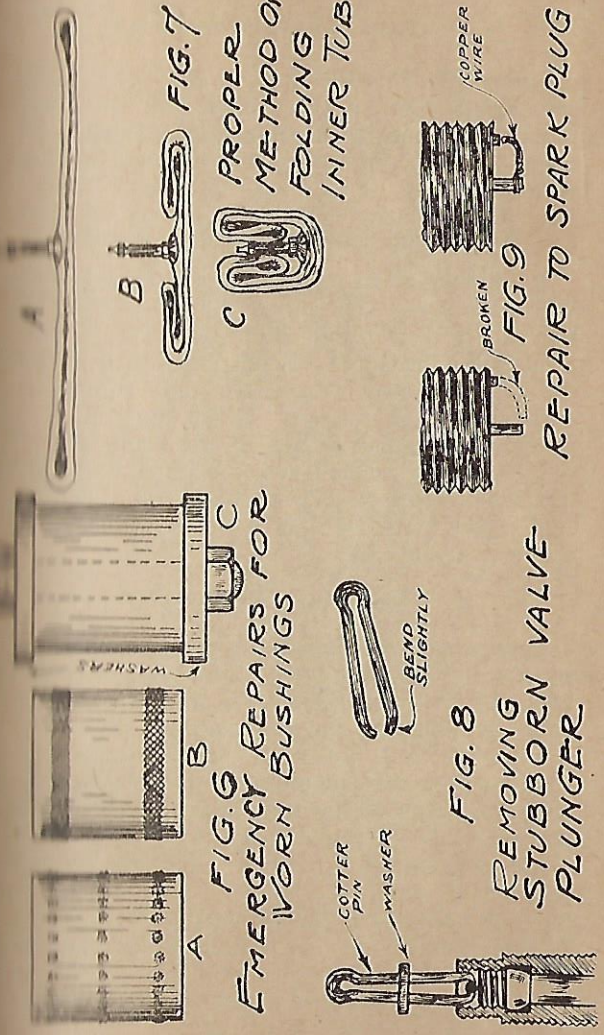
When packing an inner tube to carry as an extra, first expell all the air. This is done by removing the plunger and with the valve at one end, roll slowly from the other end. After the air has been expelled, replace the plunger. Then lay the tube flat on a table, as shown at *A* in Fig. 7, with the valve in the centre. Fold over on each side, as at *B*, and then fold up against the valve as at *C*, fastening with a rubber band. After a generous application of talc, wrap in a soft cloth and place in a tire-bag or a small box which does not allow too much freedom.

Frosting Lenses

When a plain lens has been installed and a temporary frosting is desired, paint the glass with a strong solution of Epsom salts in hot water. The solution is applied to the inside of the headlight glass, where it is allowed to evaporate. Such frosting may last for several months, and if at any time its removal is desired, it may be quickly washed off. Where a permanent frosting is desired, the glass may be ground with a mixture of water and carborundum.

Cutting Tubing

A hack-saw used for cutting brass or copper tubing, or thin, hard brass sheets, soon loses its



usefulness and its teeth. Two hack-saw blades, set side by side in the frame with their teeth pointing in opposite directions, will usually overcome this difficulty and give a cleaner, though a wider cut.

Removing Stubborn Valve Plunger

It sometimes happens that a tire valve plunger will stick below the end of the valve stem, just out of reach of a pair of pliers. Fig. 8 shows a method of removal. Bend the ends of a cotter pin slightly towards each other and slip the pin through a small washer. Grasp the end of the plunger between the ends of the cotter pin and push down the washer, which clamps the plunger securely. With a pair of pliers or a piece of wire, pull up sharply on the cotter pin and the plunger is removed.

Generator Failures

Generally, the failure of a generator is caused by a dirty commutator or brushes not making contact. In an emergency, the trouble may sometimes be remedied, for a time at least, by running the engine and holding a small cloth-covered stick against the commutator. In this manner enough foreign matter may be removed to enable the generator to function again. For better results, a piece of sandpaper may be wrapped around the stick. Use only a fine grade (about 00) and race motor for an instant after the commutator has been cleaned, so as to blow out any foreign matter which may remain. If the commutator is badly worn, with high mica bars, it

will be necessary to true the commutator in a lathe before the generator will function again.

Worn or stuck brushes, or brush springs lacking tension may also be the cause of faulty generation. Worn brushes are generally due to natural wear and tear. Stuck brushes may be caused by oil and fine brush dust collecting and caking in the brush holders. Springs may lose their tension because of a drawing of their temper, due to the short-circuiting of current through the springs instead of through the brush connecting wire or pig-tail. Lack of current may also be due to the wearing away of the insulation on the brush pigtails thereby allowing the brushes to be shortcircuited against the frame of the generator. Generally, the cause of a lack of current supply may be found in the generator itself. At times, however, a cut-out or control box may be defective. When cut-out points or regulator points are dirty or pitted very little or no current at all will be supplied by the generator. A little brushing up of the points with a fine file will remedy this condition.

Repairing Spark Plug

Sometimes, when cleaning spark plugs, one is unfortunate enough to break one of the electrodes. Generally, an extra plug is not at hand, thus necessitating a trip to the accessory store. A temporary repair can easily be made. File a small groove in one of the electrodes, twist a piece of copper wire tightly in this groove, and then bend in such a manner that the proper gap is maintained. Fig. 9 illustrates such a repair.

Where another type of spark plug is used, a mode of procedure will readily suggest itself. Such a repair, however, must not be accepted as permanent. Though it may last for quite a while, another plug should be installed as soon as possible. The rapid burning away of the wire will soon widen the gap, and besides causing faulty ignition, will place an undue strain on the ignition system in use.

Clutch Troubles

Among clutches, the multiple disc and the cone divide honors. Of the cone clutches, the direct form is in general use; while the disc clutches are grouped according to lubrication, those running in oil being called wet and those running without lubricant of any kind are called dry.

Slipping is perhaps the most common of clutch troubles. In the cone type this is often caused by oil grease or other slippery material on the surface of the clutch. This may be removed by cleaning the leather with gasoline, after which neatsfoot oil should be applied to keep the leather flexible. Again, the clutch leather may be so glazed that it will slip without any oil or grease on it. In such a case, clean the leather with gasoline, roughen slightly with a file or emery cloth, and then apply neatsfoot oil. When a wet disc clutch slips, it may be caused by either a burred plate, a weak spring or an oil which is not all squeezed out. The remedy for the last two cases is obvious; the former means removing the clutch in order to find the plate

which is burred or roughened. Before making any adjustments, it is advisable to first clean out the old oil, which may have gummed and caused trouble. This may be done by injecting kerosene, then running the engine for a time until the kerosene is thoroughly distributed and the clutch mechanism thoroughly rinsed. It should then be drained and refilled with clean oil. If the action is then unsatisfactory, the proper mechanical adjustments may be made. In the dry disc clutch, slipping may be caused by grease or oil on the clutching surfaces of the disc, or by a weak spring.

Grabbing, in the cone clutch, may be caused by too strong a spring or a hard or burned-out clutch facing. Another cause may be protruding rivetheads, in which case the heads should be hammered until they are below the surface of the leather. In the wet disc clutch, grabbing may be due to roughened surfaces and insufficient oil. The disc, instead of twisting gradually across each other as the lubricant is being squeezed out, catch at once and the car starts with a jerk. In the dry disc, the friction surfaces should be examined. If charred or glazed over, there is a tendency to engage harshly.

Spinning is also bothersome, giving trouble in gear shifting. When due to defective design, the quickest and easiest remedy is to install a clutch-spinning brake. Faulty alignment may also be the cause, preventing the engaging surfaces from entirely clearing each other. Spinning may also be due to excessive friction in the spring thrust bearing.

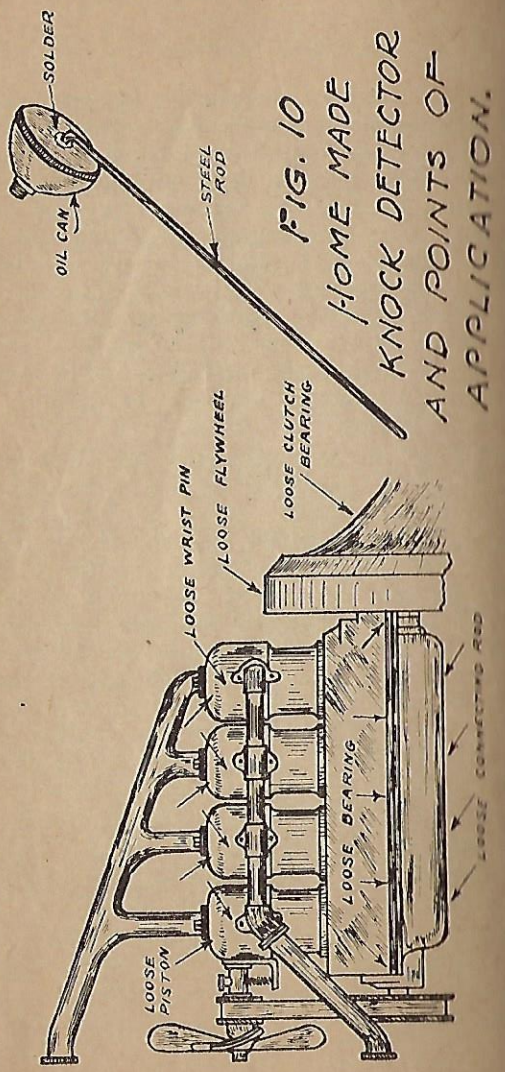


FIG. 10
HOME MADE
KNOCK DETECTOR
AND POINTS OF
APPLICATION.

Faulty clutch action may also be due to a variety of outside causes, such as improper engagement and disengagement due to connecting rods and levers, wear in the clutch collar, loosened spring tension, and other mechanical defects which can easily be corrected.

Elusive Knocks—How to Locate and Remedy Them

Knocks are elusive things—somewhat like Paddy's flea, "put your finger on him and he ain't there." The various members of the knock family are sometimes so closely related that it is difficult to determine which is making itself heard. For locating knocks, a home-made knock detector or stethoscope, is very useful. (Fig. 10.) This tool is made from an old oil can. A steel rod, about 2 or 2½ feet long, is bent at one end and soldered to the bottom of an old oil can at its centre. The straight end of the rod is placed in contact with various parts of the engine, and any knocks can plainly be heard at the mouth of the oil can. The illustration shows a few places which are subject to knocks, some of which are hard to detect with the ear alone.

CHAPTER VIII

Fitting Piston Rings

THE value of good compression is one which cannot be underestimated. As lack of power, in nine cases out of ten, is caused by poor compression, it is imperative that good compression be always maintained. Poor compression is the cause of a smaller charge being taken into the cylinder, a portion of this charge escapes during the compression stroke without doing any work and a part of the explosive force is lost through any compression leaks.

Poor compression comes from a variety of causes: Worn, scored or cracked cylinders; worn, broken or gummed piston rings; defective valve action and leaks around the spark plugs and valve caps. Leaks around the spark plugs and valve caps may readily be detected by applying a little oil while the engine is running. Any leaks will manifest themselves by the formation of air bubbles. If the valve action is in good condition, the cylinders may be suspected. When the crankcase becomes so hot as to be uncomfortable to the touch, together with a diminished engine power and a constant oil-soaking of the spark plug, it may be assumed that there is a leak between the pistons and the cylinder walls.

A piston is provided with grooves, in which rings of cast iron or steel are mounted to form a packing. The piston must fit freely in the cylinder, being a few thousandths of an inch smaller than the cylinder bore, in order to allow for expansion when heated. These packing rings or piston rings, are depended upon to prevent the leakage of the exploding gases, and, therefore, they must possess considerable elasticity in order to conform to the cylinder walls. Not being very wide, they exert but a small bearing surface on the cylinder walls, and if properly lubricated, friction is reduced to a minimum. These rings are split so that sufficient elasticity is provided for springing them over the piston and so that they may expand sufficiently to take up the space existing between them and the cylinder walls. The life of a plain piston ring is about 10,000 miles.

The causes of leaks through piston rings are many. The rings, because of gummy deposits from lubricating oil, may stick in their grooves and not press against the cylinder walls; the rings may have become broken; the joints of the rings may be in line; rings may be worn or cut from lack of oil; or the rings may not be wide enough for the grooves.

Correctly fitted piston rings will, in time, attain a glazed surface and there is practically no friction between the rings and the walls. Where the rings are defective, oil passes into the combustion chamber, which is rapidly changed to carbon deposits. Again, the flame from the combustion may work past the loose rings, prevent-

them from receiving the proper lubrication and in time scoring the cylinder walls. A deeply scored cylinder can only be remedied by reboring, reaming or grinding, and fitting oversize pistons and rings. If the cylinders are but lightly scored, they can be lapped in with an old piston covered with oil and emery or any other good lapping compound.

After the old piston rings have been removed, if any are scored or cut, they should be discarded. The grooves may contain a gummy deposit of charred lubricating oil and carbon. These deposits must be removed by a washing with gasoline, or by scraping, if necessary.

When fitting new piston rings, it is necessary that they should be of the proper length. When placed in the cylinder, the ends of the rings should not touch; otherwise there will be no room for expansion and the rings are liable to buckle. If they should touch, they must be filed (Fig. 1) using a fine mill file with little pressure. The rings should not have more than 1/64 of an inch opening, so that a good fit may be assured and the escape of compression prevented. Great care must be taken in handling rings, as they are very brittle and easily broken.

Each ring must then be fitted to its particular groove. The ring should be tried as shown in Figure 2, starting at one end of the ring and rolling completely around the piston, in the direction indicated by the arrows. Rings which are too wide must be reduced. This may be done by rubbing on a flat steel plate, using a mixture of oil and emery; or if a steel plate is

not procurable, a straight piece of wood, to which a piece of fine emery cloth has been tacked, will answer admirably. The grinding should be done with a rotary motion, only a few strokes at a time and exerting only a light pressure. The ring should be ground on both sides, and should be frequently tried in the groove, in order to avoid the danger of too much up and down play. In Figure 3 is shown a ring which does not fit the groove. It will be seen that the top and back of the piston are open, while on the opposite stroke, the condition is reversed. Such a condition offers an opportunity for serious leakage, via the back of the ring. The rings should have just a free fit, neither tight enough to jam or free enough to rock; in fact, the ring should turn easily. Average ring clearance is about from .001 to .002 of an inch.

When replacing the rings, the best fitting ring should be used for the top, so that the oil below cannot be consumed by the high temperature of the exploding gas. The replacement of the rings is the reverse of the removal. Strips of sheet metal are placed under them, as shown in Figure 4, so that a ring cannot slip into another groove than that desired, beginning with the ring selected for the bottom groove and working upward. Care should be taken that the joints or splits are not in line or too close together. A handy tool for use in working with piston rings is the ring expander, as shown in Figure 5.

After the rings have been placed in their respective grooves, they should be examined to see that they spring outward. An old ring may

have lost its tension and, therefore, will not make a proper fit with the cylinder wall. Such a condition may be remedied by peening, as shown in Figure 6. Use the ball end of a machinist's hammer, and be sure that the ring is placed on a surface as hard and as flat as possible. Any irregularities in the surface may cause distortions. By using care in peening, slight changes in the shape may be made without distorting the metal in any way.

Universal Joint Casings

The universal joints are generally covered with leather casings or "boots" which are packed with grease. These boots, when in good condition, insure the proper lubrication of the moving parts of the joints, keep out the dirt and grit and aid in making the joints noiseless.

It is advisable to inspect these casings about once a month. Flying stones or sticks are apt to partly destroy them, allowing the grease to leak out and permitting dirt and grit to enter. When not sufficiently worn to warrant replacement, they may be wrapped with adhesive tape and bound together in any convenient manner. The ease with which these casings may be replaced or repaired makes neglect of them inexcusable.

Cutting Left-Hand Threads with Right-Hand Tap

It sometimes happens that it is necessary to cut a left hand thread on a bolt when a left

hand die cannot be procured. If a right hand tap is at hand, the left hand thread may be cut without much difficulty. Into a block of hard wood, drill two holes, as at A in Figure 7. One hole is drilled so that the bolt may enter and the other is drilled smaller. The holes are so placed that they just break into each other. Into the small hole, screw the tap to about half the thickness of the block. Then fasten the tap securely with a clamp so that one cutting edge is on the center line of the holes. Then screw the bolt into the other hole, *from the other side and turn to the left.* At B, in Figure 7, is shown the block

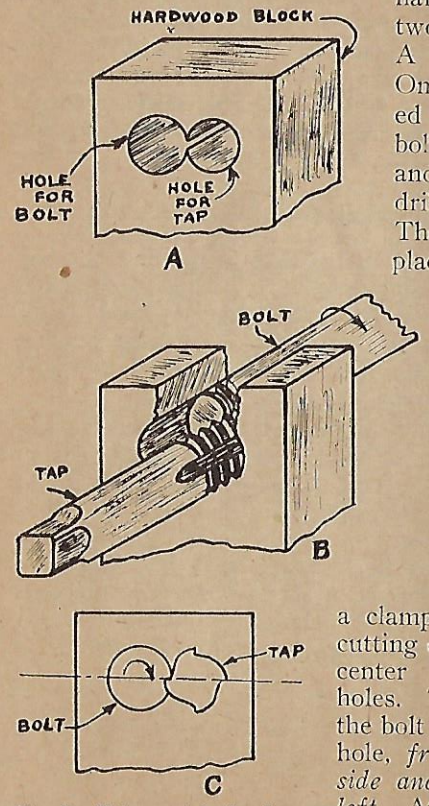


Fig. 7. Using a right hand tap to cut a left hand thread.

(partly cut away), illustrating the manner in which the thread is cut. At C, in Figure 7, is shown the position of the tap in relation to the bolt. It will be seen that one cutting edge of the tap acts the same as a lathe tool in thread cutting. Though the arrow in the illustration points toward the right, it must be remembered that the bolt is being turned in from the other side.

Radiator Overflow.

The overflow pipe, leading from the filler cap to the base of the radiator, is perhaps the last place where one may expect to find trouble. Its purpose is not only to carry off the overflow of water from the radiator, but also it offers the means of escape for steam and water vapor which is generated when the cooling system is overheated. If this pipe is obstructed, the steam has no other free outlet, and the radiator may be seriously damaged due to the pressure of the steam from the boiling water.

Filing Washers

Often a washer can be used to take up play in various parts. Generally, washers on hand are too thick and to hold them in a vise while filing the face is a difficult task. A good method is to drive a nail into a bench or a block of wood, so that the head of the nail is just below the surface of the washer. Lay the washer over the nail, file in a forward manner only, a little to one side of the centre, causing the washer to

turn slowly while filing. In this manner, an even cut can be taken from the entire surface of the washer.

Repairing Brass and Copper Tubing

Holes in brass or copper tubing can be easily repaired by the method shown at A, in Figure 8. A piece of soft copper wire is wound closely around the tube for a short distance above and below the leak. After applying soldering flux, solder is melted over the wire, making a sort of a sleeve over the tube. If the leak has been caused by rubbing over another part, this sleeve acts as a protection.

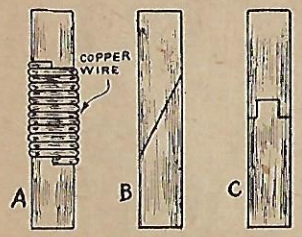


FIG. 8.
METHODS OF REPAIRING TUBING.

It sometimes happens, however, that a section of the tubing has been crushed beyond repairs and must be replaced. At B and C in Figure 8 are shown two methods of making joints. The diagonal splice, shown at B, is perhaps the quickest, but the mortised splice, shown at C, is better, especially for tubing held in a horizontal position, as the strength of the joint does not depend entirely upon the tenacity of the solder.

Rusted Fenders

Fenders, loose at the fastenings and with holes rusted through, are often seen. The most

common cause is that of neglecting the washing of the under side of the fenders, allow dirt and mud to accumulate. As rust soon forms under mud, the result is that the fenders are soon full of rust holes. A rust preventive, or an application of oil, will aid in preventing this condition, but the most reliable precaution is to prevent the accumulation of mud.

Removing Tight-Fitting Studs

When tight-fitting studs are encountered, they may be easily removed without damaging the threads. Screw two nuts on the stud and lock

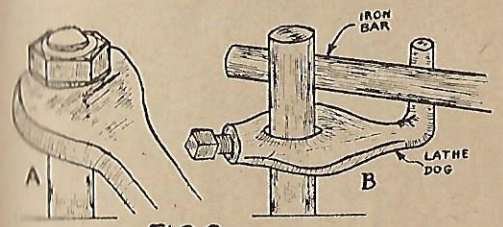


FIG. 9
REMOVING TIGHT FITTING STUDS.

them together by running one nut against the other. Then, by placing a wrench on the lower nut, as at A in Figure 9, the stud may be turned out. When it is desired to tighten the stud, the operation is in the reverse direction, with the wrench on the upper nut.

When it is impossible to force nuts on the stud, due to damaged threads, or when the above method does not bring results, a lathe dog may be used. Tighten a lathe dog on the stud, use

an iron bar as a lever, as at B in Figure 9, and the enormous pressure that can be exerted will soon move the stud.

Valve Clearance

It is advisable to inspect the valve clearance about once a month. Valve lifters, which are out of adjustment, are one of the causes of lost power. Valve clearance is necessary to compensate for the expansion of the valve stems when they become highly heated during the operation of the engine. If the clearance is too great, the valves are noisy and are liable to seat improperly; if too small, they will not seat fully when expanded and a loss of power is the result. In many cases, the exhaust clearance is a trifle more than the inlet, because of the greater expansion of the exhaust valves. Each manufacturer specifies the correct clearance for the efficient operation of the motor, and this clearance should be maintained at all times in order to obtain the most mileage and power.

Practically all motors are made with an adjustment on the tappets in the form of a screw with a hexagon head, which is hardened where it strikes the valve stem; or a piece of fibre is locked in position with a lock nut. When the engine is cool and with the valve closed, loosen the lock nut, turn the screw up or down until the correct clearance is obtained and then lock in place. When a valve is closed, the tappet or push rod underneath the valve stem can be turned with the fingers.

Priming Device

If a car is not equipped with a priming pump, or with pet cocks, a priming device may be easily installed. A hole is drilled in the intake manifold and tapped to receive either a pet cock or

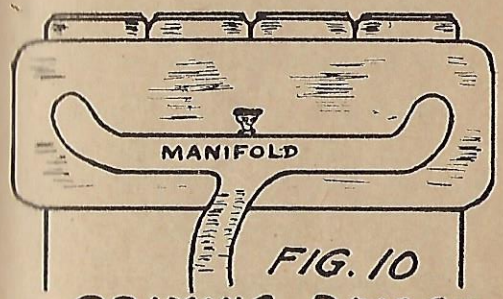


FIG. 10
PRIMING DEVICE

an oil cup with a spring cover. When a little gasoline is poured into the opening all cylinders receive a charge of gas. (Fig. 10.)

Battery Connected in Reverse

Where a car is equipped with a generator, and ammeter, if the battery should be connected in reverse, the ammeter needle will swing back and forth. The battery bucks the charging current delivered by the generator, causing the cut-out to vibrate and practically neutralizes the current produced by the generator until the condition is remedied. On some systems, the battery voltage is sufficient to influence and control the generator polarity and the generator would soon reverse

itself, charging the battery in the right direction, though the ammeter would read in an opposite direction from before. In many instances, when the generator does not reverse itself, the holding down of the cut-out switch for a few moments will cause a reversal of the generator fields and the battery would receive the benefit of the charging current. The best plan, however, is to connect the battery as it should be.

Installing a Headlight Dimmer

When a car is not equipped with small auxiliary headlights and has no dimming device, it is an easy matter to install one. Perhaps the simplest method is to install a resistance coil in the

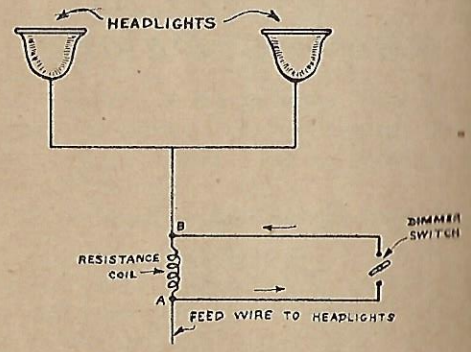


FIG. 11.
WIRING DIAGRAM FOR HEADLIGHT DIMMER

feed wire to the headlight lines. A resistance coil (which can be purchased at any accessory store) is inserted in the feed line to the head-

lights after it leaves the headlight control switch. This coil should be so mounted (on the dash or any other convenient place) so that it will not be in contact with any metallic part of car. Care should also be taken that the coil does not come in contact with any part which may easily take fire as the coil becomes quite hot when current passes through for any great length of time. A wire is run from each side of the coil to a switch, which may be mounted in the door, cowl or any other place desired. This switch may be either a snap or push switch and serves to cut the coil in or out of circuit.

Suppose the headlights are switched on, but the dimming lines are open. The current will then flow through the resistance coil and will be so reduced that only a dim light will be obtained at the headlights. If the dimmer switch is then closed, the current has another path to travel. As electricity chooses the path of the least resistance, it will avoid the resistance coil entirely and follow the easiest path. Shunting from the main feed at A, it will flow through the dimmer switch and wiring, returning to the headlight line at B. The full current is therefore delivered to the headlights and the original brilliancy is the result. For a six-volt battery, a .5 ohm resistance coil is sufficient. If the lights are too dim, the resistance can be lessened by simply short-circuiting two or more strands of the resistance coil by fastening them together. If the lights are too bright, a coil of a greater resistance must be inserted, or two low resistance coils may be connected in series. For simplicity, a single

wire system has been used in the illustration (Fig. 11) as only one side of the line need be changed. With this arrangement, it must be remembered that the headlights must first be switched on by the control switch, after which they may be brightened or dimmed at will by the dimming switch.

CHAPTER IX

All About Spark Plugs

THE spark plug is the business end of the electrical system; for regardless of how well every other part of the ignition system may be working, a spark will not occur in the cylinders if the plugs are out of order. Whenever the ignition of one or more cylinders fails, the spark plugs should be the first to be suspected. Usually, when misfiring takes place in one cylinder, especially if the misfire is regular, it is generally the plug which is at fault. An intermittent misfire may be due to a loose terminal connection, a broken wire, or to a valve not closing tightly.

The spark plugs in general use are of two types: The separable plug, in which the core or insulation can be removed; and the integral or one-piece plug. The separable type of plug has a tendency to leak compression; therefore it should have good gaskets and should be drawn up tightly. This condition is absent in the integral plug; but it is more difficult to clean.

The best position for the spark plugs is over the inlet valves; for then they will always be kept cool by the incoming gas and will always be surrounded by a fresh mixture. If placed over the center of the pistons, the plugs will

have a tendency to easily foul. If placed over the exhaust valves, besides a tendency to foul, there is an additional tendency to misfire due to a certain amount of exhaust gas which will always surround the plugs.

For best results, the spark plug should be suited for the motor on which it is to be used. It should not be too long, otherwise it may strike the valve or the piston over which it is placed. Neither should it be too short, as then a pocket will be formed which will tend to retain the exploded mixture. The spark plug should be of that length so that the points just extend into the combustion chamber. It should fit into the cylinder head, so that it can be screwed down with the fingers for at least two-thirds of the thread. If too tight, the thread may cut, making removal difficult.

The spark gap must be set with a fair degree of accuracy to secure good results. If the points are set too close, the flame area will be too small to fire the charge when running slowly. If the gap is too wide, misfiring may take place when an attempt is made to accelerate quickly. When the throttle is opened, a heavier charge is admitted into the cylinders and the compression is thereby increased. The higher compression may resist the passage of the spark to such an extent as to cause the plug to miss fire. For magneto ignition, the gap must not be too wide or the plug will not fire when the engine is running slowly. The intensity of the spark generated by the magneto depends upon the speed at which its armature is rotated and a weaker spark

therefore occurs at slow speeds. In battery ignition, the intensity of the spark is uniform, regardless of the speed of the engine. The usual gap recommended is 1/64th of an inch for magneto ignition and 1/32nd of an inch for battery ignition where vibrator coils are used. The correct gap depends upon the type of ignition system used. The gaps of the leading systems are as follows: Atwater Kent, .025; Bosch, .025; NU 4 Bosch, .016; Berling, .030; Connecticut, .022; Delco, .025; Dixie, .020; Eisemann, .025; K. W., 1/64″; Remy, .025; Splitdorf, .020; Westinghouse, 0.25, and Ford, 1/32″.

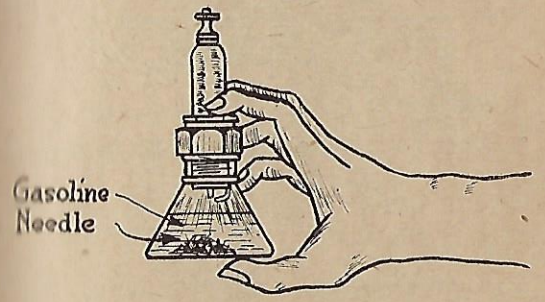


FIG.1. *A quick method of cleaing a spark plug.*

Spark plug failures are due to short-circuits, cracked porcelains, electrodes burned away, compression leaks and moisture condensing on the insulators. Short circuits may be caused by excessive carbon formations. The only cure is to clean the plug. The best method is to take

the plug apart, if separable, and clean the points with fine emery cloth. Care should be taken not to touch the porcelain with the cloth, as carbon will form more readily on a scratched surface than on one which is highly glazed. If one has not the time to take the plug apart, a quick method of removing carbon is shown in Fig. 1. An old ink bottle is partly filled with gasoline into which a number of old phonograph needles have been dropped. By placing the end

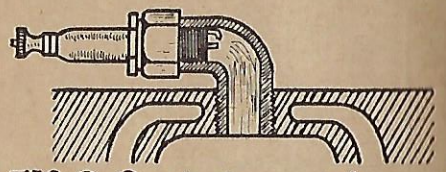


FIG. 2 Spark plug set in an elbow to prevent fouling by oil.

of the plug in the mouth of the bottle and shaking vigorously, most of the carbon will be removed.

Short-circuiting may also be caused by the cylinder pumping oil which works its way up into the plug. A thorough cleaning and drying of the plug is the only cure. Some drivers place the spark plug in an elbow, as shown in Fig. 2, to prevent fouling by oil. Though this prevents fouling to a great extent, there is the liability of a miss because of the exploded gases which are pocketed in the elbow.

Short-circuiting may also be caused by the melting of the electrode and the formation of a

small bead as shown in Fig. 3. Such a condition is an indication that the spark gap is adjusted too close.

A compression leak may be caused by faulty construction or by failure to draw the parts up tightly when assembling. Such a leak is frequently accompanied by a hissing sound and

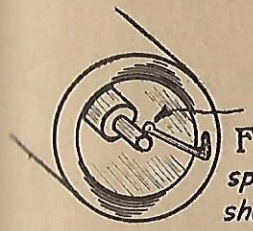
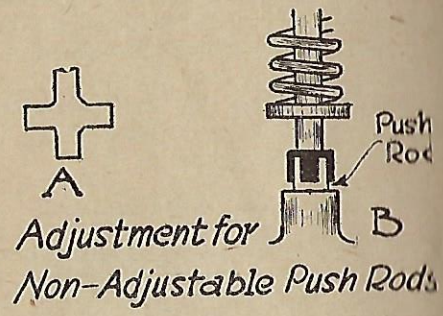


FIG. 3. Showing how spark plug may be short circuited by melted electrode.

causes poor acceleration and missing on high speed in heavy hauling. To test for a compression leak, squirt a small amount of oil around the joints in the plug while the motor is running. If bubbles appear, there is a leak.

Though a plug may fire properly while out of the cylinder, it is no indication that it will fire when under compression. A tool for testing spark plugs under compression is shown in Fig. 4. This tool consists of a piece of large pipe, capped on both ends. One end is drilled and tapped to fit the plug. The other end carries a tube which may be connected to a source of air and compression, equal to that existing in the cylinder, may thereby be produced. The end opposite the spark plug is drilled and tapped to take an old spark plug which has the porcelain

clutch pedal while the car is in motion. This frequently adds to the wearing of the clutch surface and releasing parts because of an unconscious pressure on the pedal. Only a slight



Adjustment for Non-Adjustable Push Rods

pressure on the pedal may be enough to cause the clutch to slip on a sudden pull or high speed

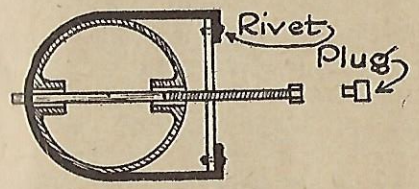
Removing a Tight Wrist-Pin

When a wrist pin becomes tight in the piston it cannot be driven out by hammering without endangering the piston, owing to the thinness of its walls. For this purpose, a wrist pin remover, as shown in the illustration, is very useful. This tool consists of a bar of iron to which a band of sheet metal is riveted. The iron bar carries a long screw which provides the driving force. The sheet metal band is drilled at its center so that the wrist pin may pass through. To remove the bushings, a soft metal plug, as shown, is placed under the screw. The smaller end of the plug should enter the bushing, while

the larger end should be slightly smaller than the outside diameter of the bushing.

Abuse of Bearings

It is a known fact that bearings suffer more from abuse than from use. Impure and gritty oils and greases, carelessness in washing the running gear and other parts of the automobile are directly responsible for much of the bearing trouble suffered by motorists. Many cases



A Wrist Pin Remover

of failure of wheel bearings may be attributed to rust formed by the careless application of a stream of water, at a high pressure, to the parts of the car in which they are mounted. The water oxidizes the steel and forms a rust which produces pits on the highly polished raceways. The rust flakes off and mixes with the oil, forming an abrasive mixture between the races, rolling members and cages. Corrosive substances in greases and oils cause an etching of the finely finished surfaces of the balls and races. Abrasives, or foreign substances, such as sand, dirt, emery, metal flakes, etc., when mixed with oil, will render the best bearing worthless in a short

time. Besides causing a grinding away of the surfaces, they are liable to pack between either the balls or between the balls and the race and thereby strain the bearing, loosening the adjustment and making the bearing noisy.

There are many ways in which abrasives may get into the lubricant. Housing castings for differentials and transmission gear cases, if not carefully cleaned, may have sand sticking on the inside corners which will loosen and mix with the lubricant. If the housings are not tight, all kinds of dirt in the form of dust will enter and be carried by the lubricant to the bearings. A careless and rough operation of the sliding gears in the transmission will break or grind off small particles of metal, which, when carried by the lubricant to the bearings, will soon cause the destruction of the highly polished surfaces.

Valve Clearance Adjustments for the Ford

The valves should open and close at certain periods of the cycle of operation and any deviation from these periods lowers the efficiency of the motor. Such opening and closing would be entirely controlled by the valve tappets if no expansion occurred in the length of the valve stem under the effects of heat. Expansion, however, does occur and a certain amount of clearance must be allowed between the tappets and the stem, so that the valves will seat properly. Wear on both tappets and valve stems increases this clearance, with the result that the valves have less lift, open late and close early and remain

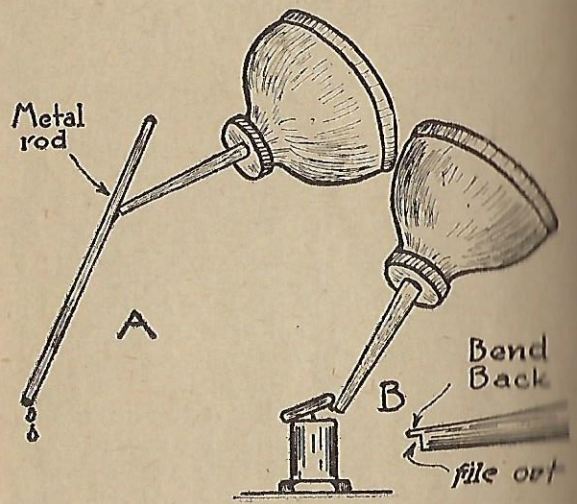
open a shorter length of time, all of which affects the power of the motor.

The Ford motor has no method of adjusting the valve clearances. Of course, various makes of adjusting devices may be obtained. The valve stems may be threaded and provided with the necessary nuts; the tappets may be fitted with a cap screw and nut; in fact, various other attachments may be procured. The fact that either the valves or tappets must be removed in order to install these adjusting devices causes many a Ford owner to defer such installations indefinitely. Perhaps the easiest method to overcome this trouble is shown in the illustration. A piece of thin sheet metal is cut as shown at A. It may then be easily slipped between the tappets and the seams and three of the lugs bent down, as at B. Thin discs of metal may then be inserted until the proper clearance is attained, when the last lug may be bent down. The clearance should be at least 1/64″ (or the thickness of an ordinary visiting card) on the inlet side; while on the exhaust it may be a trifle larger, perhaps to 1/40th of an inch. All the inlet valves should receive the same clearance and all the exhaust the same. When re-adjustment is necessary the lug may be bent up and another disc inserted.

Removing Tar

The presence of tar on painted surfaces is not serious if care is used in its removal. Scraping with a metal tool succeeds only in marring the paint. An easy method is to dip a piece of cheesecloth in crude oil and applying, allowing

it to remain for a few minutes. After wiping off with a dry cloth, if any tar remains, the process must be repeated. Naphtha, kerosene, vaseline, butter, and even oleomargarine will remove tar. After the tarry matter has been re-



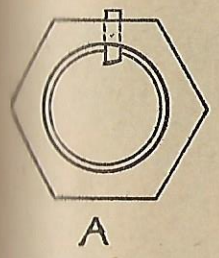
Two Oiling Kinks

moved, the car should be thoroughly washed to remove all traces of both the tar and the solvents.

Two Oiling Kinks

The car owner is sometimes inconvenienced by not possessing an oil can with either a long curved or a flexible spout. The illustration at A shows how difficult plates may be easily

reached with an ordinary oil can. By applying the oil to a metal rod, it will flow to the bottom and drop off. The type of oil cup with a dust cover held down by a spring is easily filled if two hands can be used. The one man method of lifting the dust cover with the spout of the can frequently results only in applying the oil around the outside of the oil cup. At B is shown a kink which makes the use of two hands unnecessary. The end of the spout is filed as shown and the projecting portion of the spout is bent back. This forms a hook which serves to lift the dust cap without any chance of it slipping off. The metal rod used in the previous illustration may also be formed on one end to produce a similar hook.

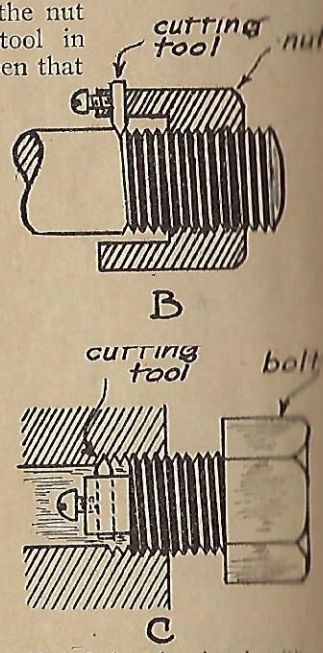


Thread-Cutting Hints

When it is necessary to extend the thread on a bolt or in a hole, the thread cutting may be accomplished without the use of a tap or die, provided that there are at least three or four threads already formed.

At B, in the illustration, is shown the method of cutting an external thread, as on a bolt. A nut of the proper size is drilled half-way through on one end, to a size somewhat larger than the bolt. On one of the flats, close to the end, a small hole is drilled for the insertion of the

cutting tool. The cutting tool may be a piece of tempered round stock, ground to a flat point on one end and held in place by a screw. At A is an end view of the nut with the cutting tool in place. It will be seen that the cutting edge is in line with the center of the nut. The threading is accomplished in the same manner as with a die. As all the cutting is done by the single cutting edge, it is advisable to take three or four cuts, lowering the tool after each cut.



Method of cutting threads without tap or die.

At C is shown the method of cutting an internal thread. In principle, this is practically the same as cutting the external thread and no explanation is necessary.

CHAPTER X

Oil Pumping

WHEN blue smoke issues from the exhaust pipe, it is an indication that the cylinders are over-lubricated. The oil works past the piston rings and enters the combustion chamber, where it burns. Though over-lubrication has no detrimental effect upon the motor, except for its tendency to rapidly foul the spark plugs and create an excess of carbon, it is not to be desired, if only from the standpoint of economy.

Over-lubrication is frequently due to carrying the oil level too high; and the manufacturers' recommendations as to its height should always be followed. It is commonly believed that the oil in the crankcase must be splashed onto the cylinder walls. This is true in a sense, but the "splash" which reaches the cylinder walls is in the nature of a mist or fog. Carrying too much oil causes the connecting rods to dip too deeply into the oil and the excess therefore reaches the cylinder walls in a real splash. However, in many cases, the oil level may be correct and oil still works into the combustion chambers. This may be due to a number of causes which should be located and, if possible, removed. The most common cause of this trouble is leaky piston rings, in which case smoke is given off at all speeds. Leakage between the piston rings and the cylinder walls may be due to the rings being gummed in their grooves, their joints being in

line, to wear of the rings or scores in the cylinder walls, and to loss of elasticity in the rings. The gumming of rings in their grooves is caused by charred lubricating oil forming in the grooves and thereby preventing the free movement of the rings. The best remedy for this condition is to remove the piston and to scrape the grooves. However, if the condition is not too bad, the rings may often be freed by a generous application of kerosene. After warming up the motor, fill the cylinder above the piston with kerosene and turn the motor over a few times so that the kerosene will work its way down in back of the rings. Allow the kerosene to remain over night and then start the motor in the usual manner. It is advisable to change the oil in the crankcase after such a treatment, so as to avoid any damage which may be done by the thinning of the lubricating oil. If excessive friction exists between the pistons and the cylinder walls, a little oil may be injected into the cylinder through the petcocks or spark plug holes.

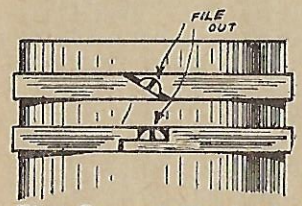


Fig. 1. Correct Method of Pinning Piston Rings

If the cylinder and the rings have worn slightly oval, leakage will be caused if the rings should turn in their grooves, as they will then no longer fit closely at all points. To remedy such a condition, the rings are often pinned in place. This, however, must be carefully done; otherwise the pins may work out and score the cylinder walls. Fig. 1 shows the best method of pinning piston rings as applied to both the miter joint and the step joint ring. A hole is first drilled and tapped in the ring groove. The screw which is inserted has half its head filed away. The ring is filed to pass around the head of the screw. Thus it will be seen that the ring cannot turn while the screw is in place and the screw cannot turn while the ring is in place, as each serves to hold the other.

When a ring has lost its elasticity, it may be peened as shown in Chapter VIII.

Some piston rings are made with a slight taper on the outside diameter. The largest side should be placed downward, thus acting as a scraper to return the excess oil to the crankcase. Should the ring be placed upside down, the oil will be scraped upward into the combustion chamber. Oil pumping does not always indicate worn parts, as many comparatively new cars pump oil. Frequently a slight change in the parts will remedy the condition. Well fitting pistons and rings will almost always remedy the over-lubrication of the cylinders. If new rings do not cure the trouble, doctoring must be resorted to.

One method is by the insertion of a special gasket, having a sort of pocket which acts as a baffle plate for the oil, as shown in Fig. 2. Such a gasket does much to retard the rapid fouling of the spark plugs, one of the most disagreeable results of over-lubrication. But it does not

prevent the oil from passing the rings and entering the combustion chamber, and therefore the chances of rapid carborization are still present. It is much better to prevent the oil from reaching the combustion chamber if possible.

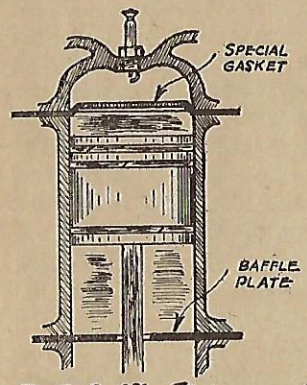


Fig. 2. Baffle Plates used to Prevent Over-lubrication

Another method is to insert a baffle plate between the cylinder block and the crankcase, also shown in Fig. 2. This is merely a plate of sheet metal which is slotted for the connecting rod to pass through.

The most common method is to slightly alter the piston. In Fig. 3 is shown a method which is usually effective. The lower corner of one groove is chamfered to an angle of about 45 degrees. Small holes are then drilled in this surface around the entire piston. These holes are drilled through at a downward angle. In operation, the ring scrapes the surplus oil into the groove formed by the chamfering. The holes serve to return the oil thus collected into crankcase. This method is usually tried on the lower ring groove. If still ineffective in preventing over-lubrication, the first groove above the wrist pin is tried.

Some motors seem to be chronic oil pumpers in spite of all adjustments which may be made. Sometimes a patented piston ring, of which there are many, proves very effective in eliminating oil pumping.

The Starter Cable

The tremedous amount of current required to start the motor makes it impractical to either fuse the starter cable or to register the amount of current flowing through. In the case of the ignition or lighting wires, any excessive flow of current due to a short-circuit would manifest itself in blowing the fuse or registering on the ammeter. As the starter cable is protected in no way whatsoever, it should be frequently inspected. Any fraying away of the insulation, allowing the bare wire to touch the metal of the car, may be the cause of serious trouble. In the one wire system, should the ungrounded cable be bare and touch any metal part of the car, a dead short circuit would result. If such a condition were to last for any length of time, the battery would be totally discharged, with the added possibility of having the plates buckled. Where the two-wire system is employed, a bare starter

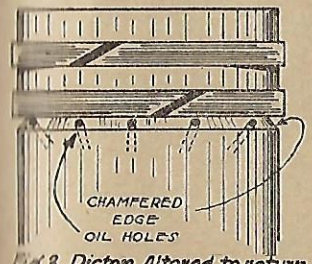
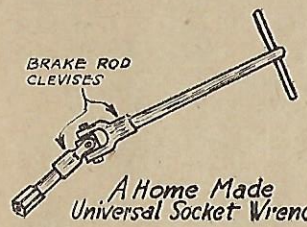


Fig. 3. Piston Altered to return Excess Oil to Crankcase.

wire would cause a "ground" if it should make electrical contact with the frame. Such a condition will also tend to discharge the battery, besides disarranging the other electrical equipment. A frequent inspection of the starting cable is, therefore, of the greatest importance.

A Home-Made Universal Socket Wrench

Almost every car owner possesses a set of socket wrenches of the solid handle type. These wrenches are very convenient to use, though there are places where the bolts or nuts are so located as to prevent a wide sweep of the handle. This means the loss of considerable time through the removing and replacing of the wrench in a different position. A universal socket wrench, as shown in the illustration, may easily be made from discarded brake rod clevises or knuckles. Two clevises are screwed into opposite sides of an iron block, forming a universal joint. The time saved by the use of this wrench will soon repay the effort required.



A Home Made Universal Socket Wrench

Speedometer Pointers

When the speedometer pointer vibrates, it may be due to loose unions, connections, flexible shaft bent too sharp, lack of lubrication

or the gears not meshing properly. When there is no indication of speed, the above causes may also be suspected, together with the possibility of a broken link in the shaft. Noise may also be due to the above causes or a lack of lubrication. In examining the speedometer for trouble start with the wheel. Examine the main and pinion gears and the swivel joint. Make sure that all the connections are tight around the swivel joint. See that there are no sharp bends in the cable. The bends in speedometer cable should be gradual, having a radius of not less than eight inches. If the shaft connection at the speedometer head is tight, the chances are that the trouble is in the instrument itself and it should be returned to the maker for repairs.

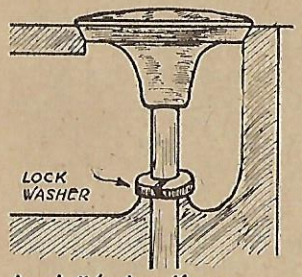
Keeping Valve Stems Clean

A sticking exhaust valve is sometimes caused by carbon forming on the valve stem and working its way into the guide. A good way to keep the valve stems clean is to place an ordinary lock washer over them, as shown in the illustration. The washer should be somewhat larger than the stem so as to prevent pinching. The washer will act as a sort of a scraper, removing the carbon as soon as it forms.

Care of the Car

In order to maintain a car in good condition so that it will give long service at a minimum of expense, it is necessary that the car be given systematic attention. Such attention is perhaps the most important in the case of a new car,

as bolts and nuts generally have a habit of loosening up for some time, and various other parts of the mechanism are liable to get out of adjustment. A new car should never be driven faster than perhaps 25 miles per hour for the first 1000 miles, a rule which applies also to an old car which has been fitted with new bearings. At such times, the engine is stiff and the wear on the bearings is rapid, though small. Bearings should be worn in slowly, otherwise a noisy engine will be the result. It is good policy to change the oil in a new car after about 500 miles of running, as the wearing away of the bearings pollutes the oil with minute particles. After the first change, perhaps 1000 miles can be driven before another change is required. It is good policy, however, to test the oil in the crankcase for quality at frequent intervals. By rubbing the oil between the fingers, some idea of its lubricating qualities can be obtained. If the oil should seem thin and possess no slipperiness, it is good policy to change the oil even if only 500 miles have been covered. Oil is always cheaper than bearings. Every few hundred miles tighten all nuts and bolts, especially those upon

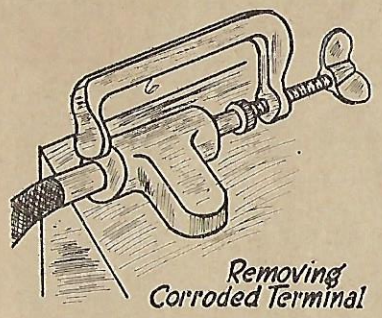


Lock Washer Keeps Valve Stem Clean

which the greatest strain is placed. The studs holding down the cylinders and those which hold the engine to the frame should be tightened from time to time. A small amount of play—even a turn of slackness—places a tremendous strain on the parts. Play between stationary parts may be quite as injurious as that between parts which move. It is not so much the possible play as the concentration of a load on the remaining fastenings which is injurious. Watch the oil and gasoline gauges for defects or improper operation; check the valve, ignition and carburetor adjustments. A slippage in the ignition timing parts may cause the spark to occur either early or late in the cycle of operation with a resultant lack of power. Test the wheels once a month by jacking up and inspecting for smoothness of operation. If a sharp click is heard when spinning the wheels, or their motion is momentarily checked, it is possible that one of the balls or rollers of the bearings is split or broken. The bearings should then be removed at once and new ones substituted. Test the wheels for looseness by shaking, and if there is any play, readjust the bearings. Keep the cooling system filled with water, and see if the water is circulating. If it is not, examine the pump and the hose connections to the radiator. In fact, go over every part of the car at frequent intervals and the liability of becoming a wayside tinker is greatly lessened.

Quick Way to Remove a Corroded Battery Terminal

Battery terminals should be kept well greased in order to prevent the formation of corrosion on them and to prevent them from "freezing" together. Anyone who has ever had a terminal tightly corroded to the battery realizes the difficulty encountered in separating them. Hammering, prying, and pulling are generally resorted to, a practice which should be condemned. Broken jars, damaged threads, plates broken from their straps and many other troubles are caused by such methods. The proper manner is to apply a steady pressure, just as if a bushing were being removed. The illustration shows a method which is quick, easy, and safe. An ordinary C clamp may be shortened and flattened on the end and kept for this purpose.

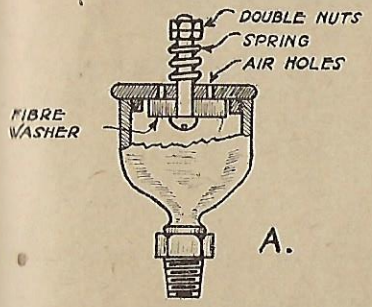


Hum in the Transmission

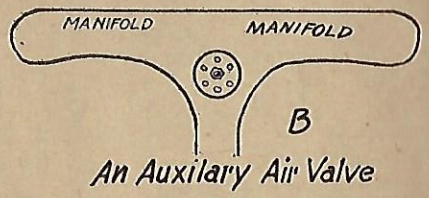
A humming noise in the transmission may be due to an excess of heavy grease. The case should never be more than two-thirds full. The best lubricant is a heavy oil that will run, or a grease of such a consistency that it will flow. Under no circumstances should a heavy grease be used unless the lighter lubricants leak out. As gears generally track through a heavy grease and receive no lubrication whatever, the lack of the proper lubrication may be the cause of a noise in the gearbox.

An Auxiliary Air Valve

The amount of gas which is drawn from the spray nozzle of the carburetor depends on the speed of the air current passing through the carburetor. The speed of the air current, in turn, depends upon the speed of the engine. At high engine speeds, the speed of the air current is much greater than at low. The speed of the engine depends upon the amount of gasoline vapor which is drawn into the cylinders. At high speeds, the engine draws into each cylinder practically the same amount of vapor per stroke as at low speeds. But, due to the increased speed of the air current, the mixture is too rich. The amount of gas is greater than is needed if the carburetor



is adjusted for low speeds. Some carburetors are fitted with an auxiliary air valve which admits sufficient air to reduce the mixture to the proper proportion. For the carburetor without such a valve, one may be easily made as shown in the illustration at A. This consists merely of an oil cup having air holes drilled through the cap. A fibre washer, carried on a screw, keeps the holes closed until the suction of the cylinders becomes great enough to draw the washer away. Adjustment is made by two nuts which regulate



An Auxilary Air Valve

the tension of the spring. The best adjustment depends upon operating conditions and can only be determined by experiment.

At B is shown the position of the valve on the intake manifold. The advantage of such a valve can readily be seen by warming up the engine and then holding the valve closed, when the speed of the engine will be noticeably decreased.

Testing Valve Seat

After grinding the valves, a good way to test the seat is to lift the valve (with the spring removed) and letting it drop. If it strikes the seat and bounces back, the seat is good. If the seat

is poor the valve will stop with a dull thud, as the uneven seat throws the valve slightly to one side as it strikes. A bent valve stem will produce a similar effect.

An Oiling Hint

Before oiling a chassis, make sure that all oil holes, even if they are protected with covers, are free of dirt. Placing oil in the proper cups does not always indicate that the friction surfaces beneath are receiving lubrication. If the oil surface is clogged, probably no oil will penetrate to the point where it is needed. It is a good practice to inspect the oil cups and their channels at frequent intervals.

the heat absorbed by the walls of the combustion chamber and that absorbed by the excessive area of cylinder wall, and as the cooling system is inadequate to the task, an overheated motor is the result.

In the high-speed motors of the present day, the timing of the ignition must be fairly accurate in relation to the movement of the piston and must be extremely rapid in action, otherwise the efficiency of the motor suffers greatly. Any wear or play in the mechanical parts controlling the ignition equipment alters the time at which the sparks flashes its way through the compressed gas in the cylinders. Wear in the linkage connecting the spark advance lever with the timer or breaker box of the magneto may cause enough lost motion so that the full movement of the spark advance lever is no longer transmitted to the ignition. The full advance of the spark lever on the steering wheel no longer represents a corresponding advance at the timer or breaker box, and, instead of the spark occuring as early as it should, there is a considerable downward movement of the piston before it actually occurs. It is, therefore, a wise precaution for the car owner to periodically check his ignition. By bringing the number one piston to its firing position and with the spark retarded on the quadrant, it is an easy matter to accurately check the timing. In such a position, the points should be just about to break, and if the wire is disconnected from the plug in number one cylinder and held a short distance from the motor, a sharp advance of the

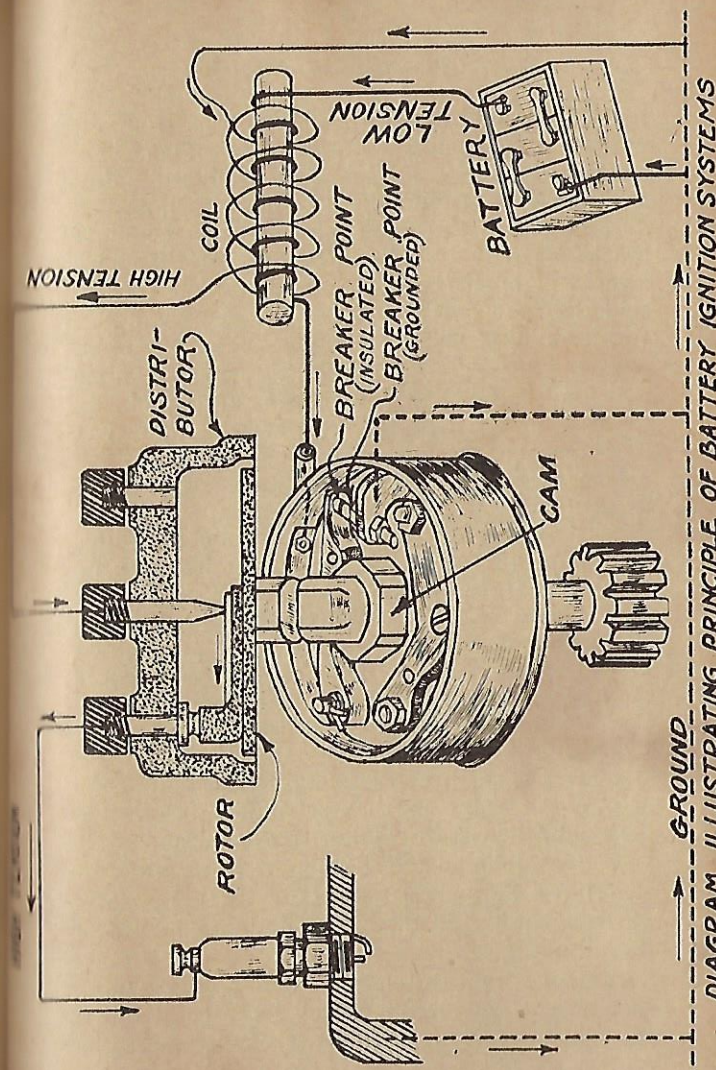


DIAGRAM ILLUSTRATING PRINCIPLE OF BATTERY IGNITION SYSTEMS

spark lever will cause a spark to leap from the wire to the ground. In the case of magneto ignition, however, no spark is produced unless the motor is running. The points, however, may be set in the same manner—just about to break—so that a slight movement of the spark lever will open them. A small pocket mirror, soldered to a soft metal handle, is very useful for examining magneto points.

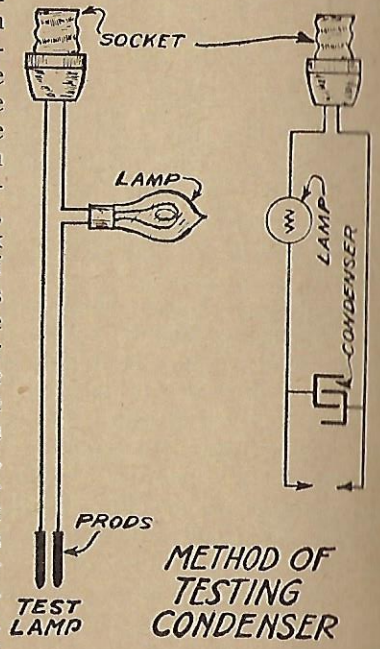
The illustration shows the principle upon which all battery ignition systems are based. In the case of the vibrating coil systems, however, the timer consists of a rotating element which makes contact with the various segments, thereby actuating the coil for that respective cylinder. Otherwise, the principle is practically the same. By following the circuit wirings it becomes an easy matter to detect any trouble. The low tension current flows from the battery, through the primary winding of the coil, across the breaker points of the timer to the ground and from there to the other terminal of the battery. When the points open a high tension current is induced in the secondary winding of the coil, which flows from the secondary terminal of the coil to the rotor in the distributor head. As the button of the distributor rotor makes contact with a segment in the distributor head, the current flows across the points of the spark plug of the cylinder to the ground, thus completing the circuit.

If the ignition system should fail, there would then be but two circuits which could be at fault: the primary or the secondary. Disconnect the

low tension wire from the timer, and with the ignition switch closed, bring it into contact with the motor. If a spark occurs, the line is complete to that point and the only other source of trouble would be that the current does not flow across the points to the ground. If such should be the case, due to a sticking breaker arm or a broken spring, the trouble should be remedied and attention may then be paid to the secondary. Connect the low tension wire to the timer terminal and with the ignition switch and points closed, disconnect the high tension wire, leading from the coil to the distributor head, from the distributor. Hold this wire about one-quarter of an inch from the motor, and if the secondary line is in good condition, a spark will leap from the wire to the motor if the points are rapidly broken by the fingers. If there is trouble in either circuit, the various parts of the system can be bridged over until the trouble is found.

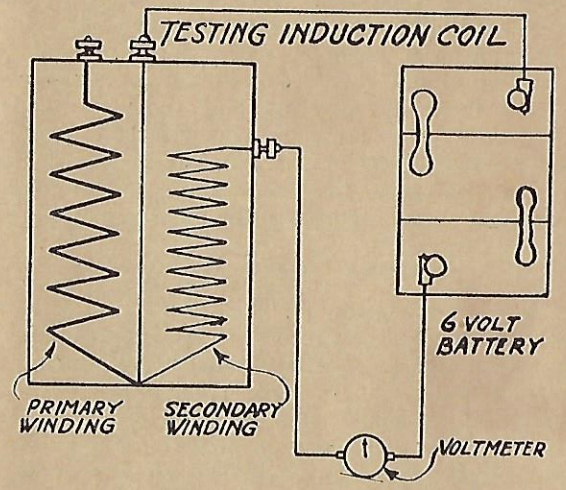
In all systems a condenser is connected across the interrupter points so as to eliminate destructive sparking. If this condenser should be defective, little or no high tension spark will be obtained. By the use of a test lamp, as shown in the illustration, the condenser may be tested. This outfit may consist of either a 110 or a 6-volt lamp, with a suitable socket and wired as shown. Disconnect the wiring from the primary or low tension terminal of the breaker box and place a piece of fibre or other non-conductor between the interrupter points, thereby keeping them from making contact with each other.

Connect the test lamp to a source of current and bring the prods or ends of the wires together so that the lamp will light. Pay particular attention to the intensity of the spark at this time. Now bring the ends of the test wires to the breaker points. If a ground exists in the condenser, thereby making it defective, the lamp will light. If the condenser is in practically a good condition there will be no light. Remove the insulation from between the interrupter point and with the test wires in the same position, allow the points to come together. If the condenser is in first-class condition, a bright, snappy spark will occur. If the condenser is defective, there will be little or no spark. The principle of the test is shown in the illustration, where the arrows represent either the ends of the condenser wires or the interrupter points. The coil seldom



METHOD OF TESTING CONDENSER

gives any trouble, but should it be suspected, it may be easily tested. The test lamp outfit will detect any break in the primary winding, as only a continuous winding will cause the light to light. This test, however, will not detect any short circuited layers of the winding. The best method is to use a line from a storage battery and with an ammeter connected in the line,



apply the current to the primary terminals of the coil. Generally, from 4 to 6 amperes will be drawn by the coil, though the amount of current consumed will depend upon the make of the coil. If an excessive amount of current is drawn, that is—much in excess of 10 amperes —it is safe to assume that the primary winding is short circuited and the coil should be returned

to the maker for repairs. The secondary winding may be tested in the same manner. If a test lamp is used, only a faint light wil show, due to the high resistance of the secondary winding. The use of a voltmeter and battery, as shown in the illustration, is a more positive test. If the voltmeter shows no reading, the secondary winding is open. If the winding is in good condition, the voltmeter will show a reading of about one-half the battery voltage, or three volts.

If the other parts of the system are kept in good condition, such as clean and properly adjusted interrupter points and tight terminals, very little trouble will be encountered. Should any serious defects arise in any parts of the system, however, they should not be tampered with, but should be sent to the maker for repairs.

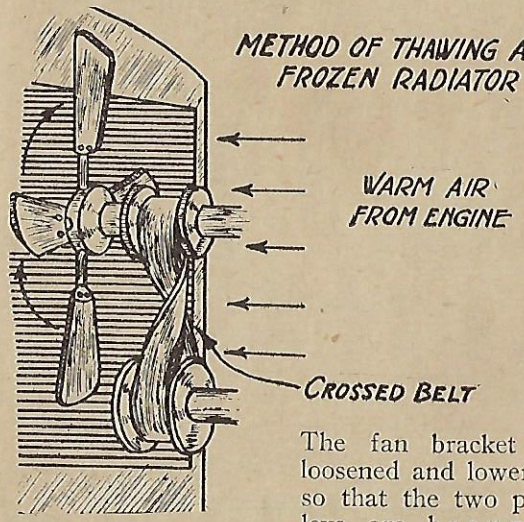
Injecting Carbon Remover

A great many car owners use a liquid solvent for the removal of carbon. The general manner in which this solvent is applied is by pouring a certain amount in the spark-plug holes. Naturally, but a small surface is covered by this method. A good way in which to apply any solvents is to use an ordinary atomizer or bulb syringe. The solvent may then be sprayed over a much larger surface and will, therefore, be more effective.

Thawing Out a Frozen Radiator

When the radiator freezes, it usually means disaster, as the expansion of the water on freezing causes the joints of the radiator to open or

cracks the water jackets. It is best, however, to first thaw out the radiator before taking anything for granted. The best way to thaw out a frozen radiator is to pour hot water over the bottom, as it is here that freezing first takes place. If hot water cannot be procured, a quick and easy method is shown in the illustration.



The fan bracket is loosened and lowered so that the two pulleys are brought closer together. The fan belt is then removed and crossed, as shown in the illustration. The belt is then adjusted to the proper tension and the engine is started. The crossed belt causes the fan to revolve in the opposite direction and the warm air from the engine is therefore blown through the radi-

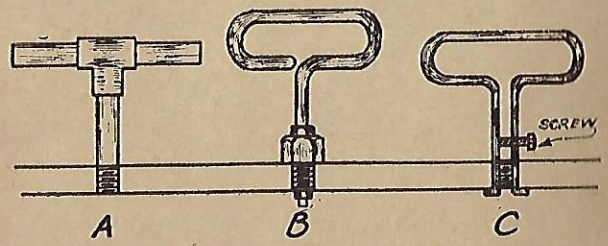
ator. Owing to the altered position of the fan, it is advisable, before starting the motor, to see that the fan blades do not strike anywhere.

Locating a Puncture

Small pin hole punctures are difficult to find; though immersing the tube in water readily discloses the leak. However, water is not always at hand when on the road; in which case the following method will help. Slightly inflate the tube and then hold it close to the ground. Turn it slowly so that each part of the tube will be brought close to the ground. The puncture can usually be located by the disturbance made in the dust by the escaping air. A little tire talc or cigar ashes spread on the ground will make the disturbance more readily noticeable.

Cylinder Head Lifters

Removing and replacing cylinder heads is an awkward job, which may result in bruised knuckles or burrs on the cylinder heads. For

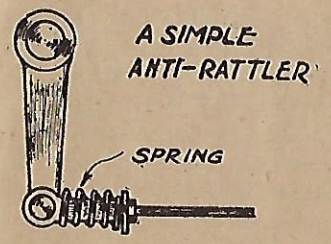


CYLINDER HEAD LIFTERS

this purpose, a pair of lifting handles will be found very useful. The illustration shows three types of easily-made handles. The handle shown at A is made from pipe fittings. At B, an old spark plug is used to attach a handle to the cylinder head. The handle shown at C is made of flat stock. The prongs are pressed together for insertion in the spark plug hole. Turning down on the screw causes the prongs to spread.

An Anti-Rattler for the Brake Rods

A brake rod rattle is annoying to one who enjoys quiet driving. A simple "anti-rattler" is shown in the illustration. It consists merely of a fairly stiff coil spring which is slipped over the clevis. One end of the spring presses against the lever arm, while the other end presses against a washer held in place by the lock nut on the brake rod. This takes up the lost motion which causes the rattle.



Greasing Front Wheels

A front wheel need not be removed every time grease is to be applied. Simply remove the hub caps, fill them with grease and then screw

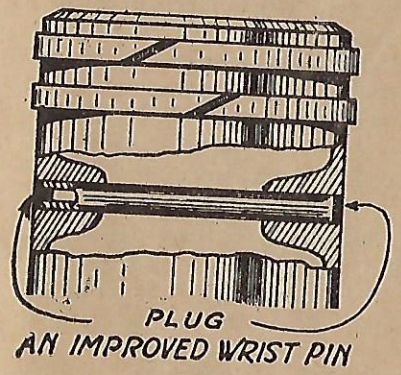
them in place. This operation should be continued until the grease is forced through all the bearings and out through the small clearance on the opposite side of the wheel. It is good practice to do this often so that grit and dirt will not enter the bearings. Grit will always enter a dry bearing; but it will never enter a bearing that is well filled with grease.

Lost Compression

The usual causes of lost compression are faulty valves or piston rings. A number of causes will cause a leakage of compression at the valves. The valve stems may stick; the push rods may be fitted so tightly that they will not allow the valve to close; the valve spring may be broken or carbon has lodged on the valve seat. Piston rings which are worn, scored or broken will also cause lost compression; as will rings which have turned so that their joints are in line. If the leakage does not occur at the valves or rings, it must occur where the valve caps, priming cups or spark plugs are inserted into the cylinder; or between the cylinder block and cylinder heads. The remedy is to overhaul the valve mechanism and to grind the valves if necessary; the installation of new piston rings, provided that the walls are not scored; or the tightening of all caps and plugs which screw into the combustion chamber. If the leak exists between the cylinder blocks and cylinder heads, the installation of new gaskets is advisable.

Improving the Wrist Pin

On some pistons, the connecting rod swings on the wrist pin, which is made a tight fit in the piston. From continued use, however, the wrist pin develops a tendency to loosen, which sometimes permits the wrist pin to work to one side and rub on the cylinder wall. When this occurs, a scored cylinder is usually the result.



AN IMPROVED WRIST PIN

To prevent such misfortune, a good plan is to fit the wrist pin with soft brass ends, as shown in the illustration. If the wrist pin is hollow, it is merely necessary to shorten it and to force a soft brass plug in each end. Solid wrist pins must first be drilled for a short distance to accommodate the plug. Should such a wrist pin work loose, no damage can occur, as the brass ends are softer than the cylinder walls.

CHAPTER XII

Straightening Axle Shafts, Crankshafts, Stems, Front Axles, Frames, Etc.

STRAIGHTENING of parts and sheet metal work may be termed a salvaging operation. Because of the extensive use of steel bars, tubes, forgings and sheets, there are very few parts of the modern motor car that can not go through quite a wreck and come out of it in such shape as to be beyond straightening. This salvaging of wrecks presents great opportunities to the repair shop, and yet few mechanics are able to do a good job of straightening.

Perhaps this is because it is hand work, very tedious in a good many cases, showing very little return for the amount of time required. Each case requires a complete analysis, to determine the best method, tools required, etc. Different kinds of dents in bodies and fenders require different treatments, while parts made from bars, tubes or forgings will also require different treatments, depending upon their general shape and condition.

There are more calls for men to do straightening of some kind than there are for men to do lathe work, and skill in the former line is certainly more valuable than in the latter. While this work seems difficult it is really quite simple when one understands the principles and has

mastered his patience. We claim that it is reasonable to assume that all shops get a good many calls to straighten parts, but are forced to pass up this business, either because they feel that they do not have the proper equipment, or that generally the average mechanic does not possess the skill and for this reason it is not profitable to attempt such work.

While the manner in which the work is done depends largely upon the shop's equipment, it can not be said that elaborate equipment is required. Vises, presses, anvil, and hammers will usually serve the purpose. Some shops, of course, have all this equipment, while others have part of it. However, it is hoped that the following paragraphs and the illustrations presented herewith, will present this subject in such a manner that any mechanic can apply the principles to his own jobs and tools. There is no good reason why garages and repair shops should turn down such work, except that mechanics do not know how to do it.

There are many parts in a motor car that must of necessity be made light to hold the weight of the complete vehicle within reason and these, of course, suffer when in a wreck or when abused. Salvaging or straightening—is a bending back process that restores them their original shape within practical limits. The amount of bending that parts will stand depends upon their shape and composition. Some will stand bending almost double and the straightening operation, while others will stand considerable bending in one direction only. However,

there are many pieces in the latter class which can be straightened to their original shape if heat is applied properly.

As a general rule straightening will mar the appearance of a part which in many cases is of no importance, while in some cases special pains must be taken to protect the surfaces from dents and bruises caused by the straightening tools, so that pieces of leather fastened to wood blocks must be interposed between the work and the tools. Tubing is noted for the way in which it flattens when bent, however, there are ways of bending tubing without collapsing it, but they can hardly be applied in the repair shops. In this case the work is usually a compromise, fortunately most parts made from tubing do not have to be perfectly round and straight. The work is usually done as neat as possible and the part then rounded or shaped with the file. These parts must generally be repainted, which covers the slight defects which remain. There are other parts such as crankshafts and connecting rods which often require straightening. These parts, of course, must be made accurate and frequently it will be found cheaper to replace them rather than to attempt straightening. Shafts of any kind must be straightened on centers in a lathe, or a temporary device giving the equivalent of lathe centers can be devised with a pair of vises clamped of the work bench. The average shop is usually equipped with a lathe which will take care of crankshafts, axle shafts, etc.; however, propeller shafts are usually beyond the capacity of the lathe and must be

straightened on the bench. The propeller shaft as a general rule is of tubular section and has been bent due to whipping under high speed. Its condition is usually such that it will not pay to straighten it.

Heat as an Aid in Straightening

Heat is a great help in straightening many parts, particularly bulky parts, such as front axles, frames, etc. Some parts are so rugged or the bends so badly located that the work cannot be done unless they are heated to a red heat. Parts which have a sudden change in section or those that are deeply nicked invariably crack if the bend is straightened cold. Heating softens metals and considerable care must be used in handling and in using tools for the heated surface can easily be marred. The majority of motor car parts undergo some form of heat treatment, which is nullified in that section which has been in the fire. There is bound to be some loss of strength, as it is highly improbable that the part will again receive as correct and uniform heat treatment as the original. This also applies to cold straightening—the fibers of the metal will loose a fraction of their strength unless the bend has been very slight. An ample factor or safety is usually incorporated in the design, so that it is not unsafe to put back on the car any part which does not show evidence of fracture.

Speed in straightening comes mostly from the ability to select the point of greatest bend and to apply the pressure there without creating

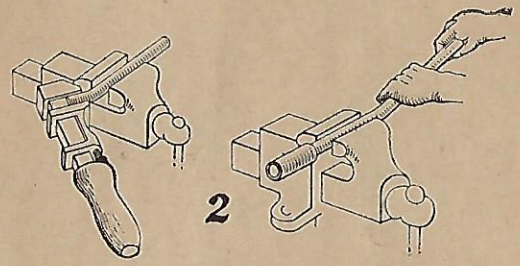
other bends. The amount of pressure or force must be determined by trial—several applications usually being required to take out one bend and it is better to give the piece not enough than too much. When a part is badly twisted the logical way to work is at one bend at a time, getting it straight with the eye before attacking another bend, then if a real accurate job is required it can be finished up without a decided crook to combat at each trial.

Simple Straightening

The simplest form of straightening applies to parts such as brake rods and shafts which have a slight bend in them. In some cases this can be done by holding the piece in both hands and twisting it. This, of course, can only be done on very light pieces, while the results will only be approximate. Another method is bending the piece over the knee, or standing on it and raising the fore end far enough to effect a set.

The quickest method for all approximations is by means of the hammer and anvil as illustrated in Fig. 1. Two types of bends are shown, while the arrows indicate where to strike with the hammer. Eye straightening in cases of this kind will usually suffice, so that it is not necessary to line up the part. Straightening in this way will usually mar the piece, and if this is to be avoided some means must be provided.

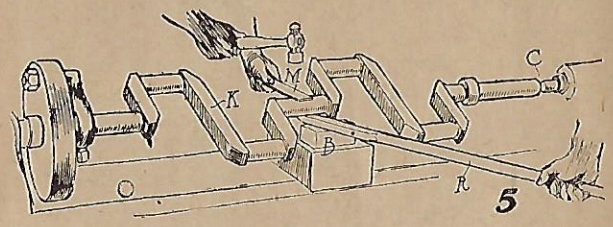
Blocks of wood, leather lined, can be used between the hammer and the part. The bench vise also forms a valuable asset for straightening of this kind, as the bend can be placed between the jaws and gradually straightened by the pressure of the jaws. Another method of straightening with the aid of the vise is shown in Fig. 2.



In using the vise and wrenches, one must eliminate friction in order to get the full benefit of their power. Vises should always be kept in proper condition; the screw and sliding parts should be kept free from dirt and well lubricated. It should also be kept firmly attached to the work bench.

Another powerful device that can be used for straightening is the arbor press; however some method must be provided to prevent round parts from rolling. This can be accomplished with V blocks, which can be made from iron or steel castings, or purchased from machine tool supply houses. Blocks can also be made from

ably worn out of round. The test should be made at the side of the bearing where little or no wear is liable to take place. Very few re-



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pairmen will undertake the job of straightening a crankshaft; however the means generally employed is shown herein. Fig. 5 shows the shaft fixed between centers in the lathe, a block B is placed upon the lathe bed for a fulcrum and a bar of iron or wood "R," preferably wood, is used as a lever. If an iron bar is used a piece of soft metal such as lead, brass or a piece of wood, should be placed between it and the bearing surface of the shaft for protection. Assuming that the shaft is bent as indicated by the dotted line A in Fig. 6, it is pried up with the bar until it assumes the position indicated by the dotted line B, and while held in this position an assistant holding a piece of brass, M, on the bearing surface with one hand, and with a hammer in the other, strikes the shaft a sharp light blow. The bar and blocks are then removed, the lathe

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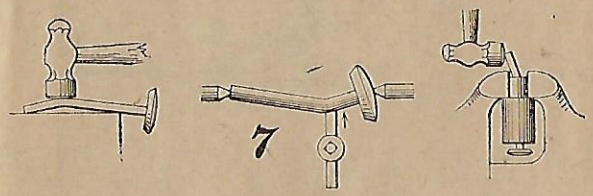
started and the shaft again tested. This treatment must be repeated until the shaft is straight as indicated by the line C. If the shaft is not provided with centers it will be necessary to chuck one end and support the other in the steady rest of the lathe. In either case it is a long and tedious job, depending greatly upon the chance and the ability of the operator of the bar to guess the proper amount of pressure to apply and the proper place to apply it.

Straightening Valves

Valves can be tested and straightened in the lathe. Fig. 7 shows how by using the cross feed, a piece in the tool post can be used to force the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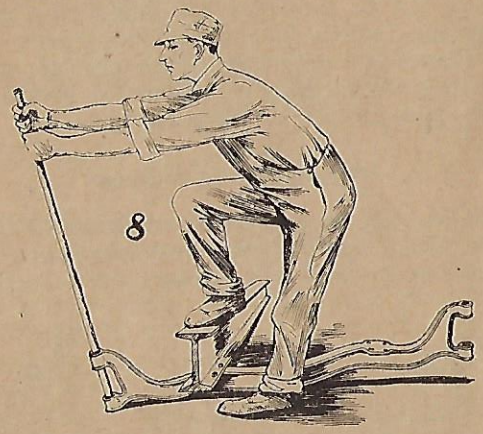
stem straight. Valve stems are not so heavy as to injure the lathe by this method, which is quick and convenient. Another way is to straighten out by hammering on a bench block or anvil. The scale test, Fig. 3, is a good one for valve stems. The bend should be taken out first, which can be done without breaking anything—in the manner shown. If a valve slides freely through its bearing in any position that is all the test it needs.

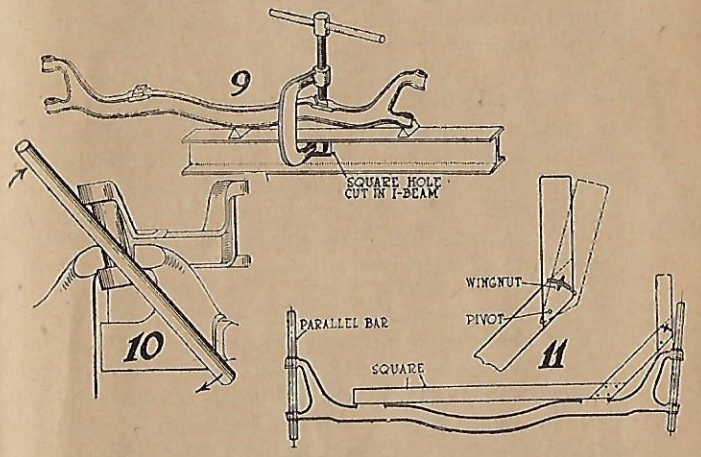
Front Axles

To straighten front axles it is usually necessary to heat them about the portion that it bent, which will permit straightening by either of the



methods shown in Figs. 8 or 9. There are also other ways of straightening, such as blocking up the shop crane and using the chain block to apply the pressure, or they may be gripped in the vise as shown in Fig. 10. Some judgment must be used by the mechanic as the method that can be used will depend entirely upon the nature and location of the bend. Fig. 11 shows the method of testing axle with a parallel bar and an adjustable square. One leg of the bar is pivoted so that it is adjustable to determine the amount of bending required to line it up with the opposite end.

Steering knuckles and levers as a rule can be replaced for less money than the cost of straightening. In any event this is advisable, as these parts are usually made from alloy steel, heat

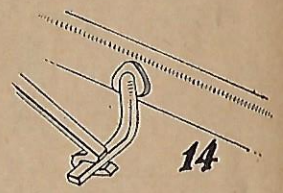


treated, and are vital to the safety of passengers.

Axle Housings

Rear axle tubes and housings when made of pressed steel are the most unsatisfactory parts to straighten that come into the repair shop. The flanges and housings and bearings that are riveted to these members make the assembly very difficult to set up and to apply any kind of pressure to in an effective manner. Because of these projecting parts this member can be more easily straightened if heated—then a light-

is a very handy tool for most any straightening job and can easily be hand-forged from 1-inch square steel or larger with the handle made in proportion to the size of the bar. The tool is of particular value in straightening the various parts riveted to the frame such as running board supports, fender irons, lamp brackets, etc. With its aid the most refractory part can be straightened back if it is get-at-able, and without taking out rivets. To avoid undue strain on the rivets or bolts it is advisable to use two bars, one acting against the other. Fig. 14 illustrates the method of applying the straightening bar to a running board support.



CHAPTER XIII

Removing Dents from Bodies, Fenders, Tanks, Etc.

THE straightening of sheet metal parts such as fenders, bodies, tanks, hoods, apron, etc., will be found to be a much more tedious job than straightening chassis parts, shafts, etc., owing to the thin section of the metal used which makes it difficult to work to its original shape. If a considerable amount of this work is to be done, it will require an assortment of tools and equipment. Each particular problem must be analyzed to determine the best method of accomplishing the straightening in the shortest or a reasonable length of time. A variety of ideas have been presented in trade journals, however most of these are beyond the scope of the average-repair shop. In what follows an endeavor has been made to describe how this can be accomplished in the majority of cases with a limited amount of tools, which can be made by most any mechanic.

The flattening and shaping of sheet metal to remove indentations requires the use of a reasonably soft hammer, that will tend to preserve the finish of the surface, and some means of supporting the surface while hammering to confine the work to the wanted region of the sur-

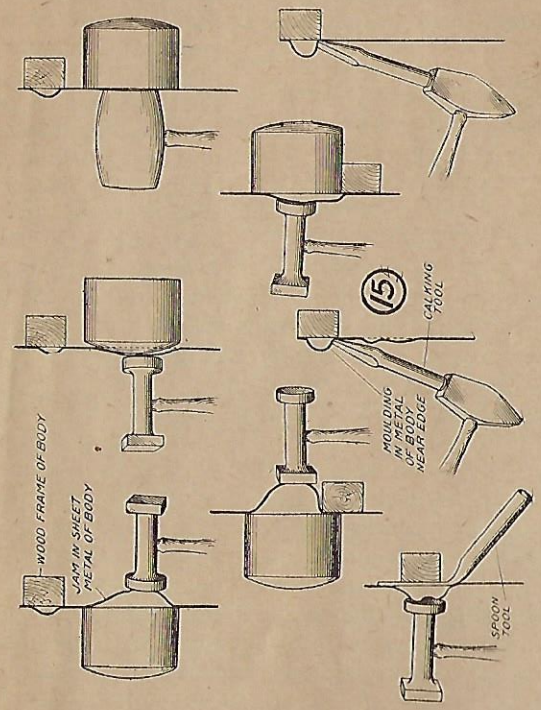
face. An ordinary sad iron having rounded corners can be used, or a special support can be provided, such as a hand block made from a piece of shafting 3 or 4 inches in diameter. One end can be turned convex, while the other end is left flat. One side can also be made flat so as to give a surface about 2 inches wide to broaden its scope. This, then can be used on either side when hammering.

Bumps or jams in body sides which are not too irregular can sometimes be removed by pressure, which will cause the metal to resume its original shape more readily. For applying pressure wood forms can be made and the pressure applied with large clamps gripping on the wood forms. Care must be taken to hold the forms rigidly so that they will not mar the adjacent surface. If hammering must be resorted to, a carefully worked out plan should be followed.

The tool equipment should consist of several sizes of wood mallets, a steel hammer to be used for finishing with a round and a square surface, a calking tool and perhaps a hand-forged spoon for use as a support when the dent is obstructed by the wood frame of the body. Several of these spoons of various shapes can be forged from steel bars. In doing any work of this kind it is necessary to remove the upholstering around the dented portion. Care should be taken to note how this is attached so that a neat job can be made when replacing same. One must have ample space to work on both sides of the damaged section and in some

cases it may be necessary to remove a part of the wood frame of the body.

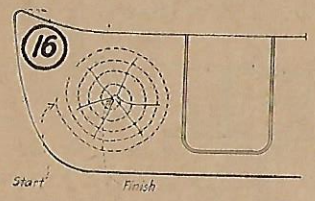
Fig. 15 illustrates the various tools mentioned



above and the method of applying them. This shows some of the common problems and how the dents are removed. Sometimes it is possible to use the calking tool and draw the metal to-

ward the moulding or the body which is usually integral. In this case the moulding will be slightly upset, but not visible to the eye.

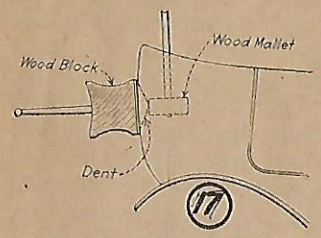
When the buckling is in an ugly place, as is caused by a wagon pole striking in side of the body, the hammering should begin at the extreme edges of the bent place and by working around in a circular direction the metal can be gradually brought back to an even surface. This is illustrated in Fig. 16, the spiral dotted line indicating the path of the hammer blows. Use numerous light blows of the hammer and keep the support close up against the metal, working always around and gradually toward the center. Go carefully at first, as it is better to undergo the work than overdo it, and if the desired results are not obtained, start again and repeat the hammering. Never use a machinist's hammer as this only expands the metal in spots and leaves the surface irregular. The purpose in using a wood mallet or even a lead hammer, is to gradually force the metal without expanding any more than necessary.

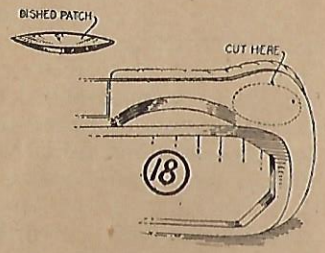


As previously mentioned, small dents can sometimes be removed by applying pressure to wooden forms. These forms should be a slight exaggeration of the desired surface. Blocks shaped to the desired surface are also of assist-

ance in hammering when used as illustrated in Fig. 17.

There are many other methods such as soldering, welding, or puttying over the surface and then repainting. In a good many cases repainting is necessary and such being the case, welding would appear to be the quickest and most convenient method. If the damaged surface is large it may be necessary to remove a section of the body and to replace it. Fig. 18 illustrates a method of inserting a patch and welding. Surfaces of both patch and body must be scraped bright and the patch should be dished to give the desired surface. Shaping the patch also guards against contraction, as it is almost impossible to protect a body to prevent this. In removing most any indentation no matter how slight, the paint on the body about this point will crack, and it therefore becomes necessary to retouch the surface. If the dent is in one of the doors it can be removed and straightened on the bench or returned to the factory for repairs.





Tanks

On gasoline tanks and other inaccessible places it is necessary at times to obtain a support for the center of the bend from the outside. This can be done by sweating a valve or other piece of metal to the damaged surface as illustrated in Fig. 19, to obtain a hand grip and force the buckled part outward while hammering around it. It will be noted that the hammering does not contract the metal, it can only extend or expand it, and what occurs when the buckled plate is apparently flattened, is that the surface is ridged around the bend, some of the metal being below and some above the true surface. The appearance of this ridging is overcome when the surface of the metal is repainted. Some of the tanks used on the early types of cars were built up with ends riveted and soldered in position. In this case an end can be removed and the damaged surface reached from the inside. Some makers advise returning the tank to the factory for repairs which usually will mean laying up the car for several weeks. This certainly is not desirable, and if the tank is damaged beyond repair in the shop, it will be found as cheap and far more satisfactory to replace it with a new one. All the accessories, such as filler and cap, gauge, etc., can be removed and inserted in the new tank. In making repairs on tanks, they

should always be tested for leaks, as these will occur particularly in soldered tanks when straightening. Air pressure is the best for this purpose, about 5 lbs being sufficient, when the tank is submerged in water. If leaks are present, air bubbles will show on the surface of the water.

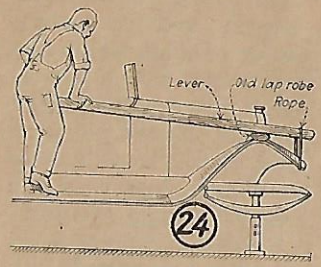
Radiator Shells

Radiator shells are frequently dented in collisions, and as these are made of steel with a detachable core they can be dismantled and straightened with blocks of wood acting as forms and heavy clamps to force the metal to the desired shape. In the majority of these cases the core is also damaged making repairs necessary, so that the time required to dismantle must be considered as essential. In some cases straightening will cost more than a new shell, but the latter usually requires laying up the car for several weeks, since these are seldom carried in stock by distributors. Thus the loss in laying up the car may be many times that of straightening. The repairman should carefully analyze each case and consider all factors involved before advising his customer. An estimate on straightening should be made and compared with the cost and labor of installing a new shell and the time involved in laying up the car.

Hoods

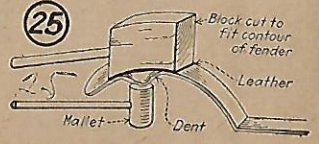
The straightening is hoods is usually simple and can be done with a wood mallet and an anvil. However, if the dent is in the sides which

When fenders become bent the custom of most repairmen is to remove them and take them to a tinsmith for repairs, or they are shipped to the factory for restriking in the press. This involves considerable trouble and delay as well as involving unnecessary charges to the owner.



There are various methods which may be resorted to, some of which have been outlined above.

With a sharp bend in the fender, as from backing against it, this frequently can be straightened out by pulling against it, in the opposite direction, from which it was pushed in. Place a jack or lever under it and gradually raise it, noting the result. When the metal is ruptured, the surface can be gradually worked back into shape, and the edges of the ruptured spot held evenly and soldered together. A better method is to fit a piece of sheet metal to the surface shape of the broken part and sweat this to the back of the opening. There are several methods of using leverage to remove simple bends. Fig. 23 illustrates one method, while Fig. 24 illustrates another method of removing a bad bent. In this case considerable lever-



age is necessary and sometimes assistance must be given with the mallet. Dents are more difficult to remove and usually require hammering as illustrated in Fig. 25. In this case a block of wood is shaped to fit the center of the fender and used as a support for hammering.

In Conclusion

The peculiar process of manipulating sheet and other metal parts, which has been the object of this discussion, if required, will prove immensely useful to the workman in innumerable instances of a wide range of repair and construction work connected with motor cars.

From the lengthy description the reader may assume that repairs such as these would take an unwarranted amount of time to carry out. On the contrary, however, it is a matter of experience and observation that a skilled mechanic would easily dispose of such repairs without an undue waste of time.

A good many parts are junked owing to the lack of capable mechanics who have the training and patience to salvage them. The demand for mechanics capable of doing such work is continually increasing and will continue to increase as motor cars increase in number.

(*End.*)